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Chapter 7

Clutch Problems, Troubleshooting, and Service

After studying this chapter, you will be able to:

- ❑ Describe the common problems that can occur in a clutch assembly.
- ❑ Adjust a clutch.
- ❑ Remove a clutch assembly.
- ❑ Inspect clutch parts for wear and damage.
- ❑ Remove and replace a flywheel and a pilot bearing.
- ❑ Disassemble, repair, and install various clutch parts.
- ❑ Install a clutch assembly.

Technical Terms

Riding the clutch

Dumping the clutch

Clutch drag

Clutch slippage

Grabbing clutch

Clutch chatter

Clutch vibration

In-car service

Clutch adjustment

Constant-duty throwout bearing

Bleeder valve

Radial runout

Lateral runout

Introduction

This chapter explains how to diagnose and service clutches. Clutch problems and their causes are identified. Procedures performed with the clutch in place, such as clutch adjustment, are covered. Major repair and replacement procedures, which require clutch removal, are also explained.

Clutch Problems and Troubleshooting

You cannot properly service a clutch until you know what is wrong with it. In many instances, a clutch problem that seems to be severe is minor and easily remedied. In other cases, the solution involves replacing the clutch assembly or some other major component. Check the easiest, most obvious solutions (such as clutch adjustment) before removing the clutch. Also, look beyond the clutch for possible solutions. Consider the possibility the problem is something other than the clutch. **Figure 7-1** shows typical clutch problems. Study them carefully.

Clutch discs are like brake linings: they gradually wear out as they operate. Every time the clutch is engaged or disengaged, some friction material is removed from the clutch disc. The amount of material lost during each action is small, and most clutches will last for 50,000 miles (80,000 km) or more. It is normal for a clutch to wear out after this mileage is reached.

Often, however, a clutch will not last as long as 50,000 miles. Like any other mechanical part, the clutch can be damaged by careless or abusive operation. Further, it can be damaged by outside factors—factors that cannot be attributed to the vehicle operator. It is important for you, the technician, to find out what caused the premature clutch damage, so the problem might be prevented in the future.

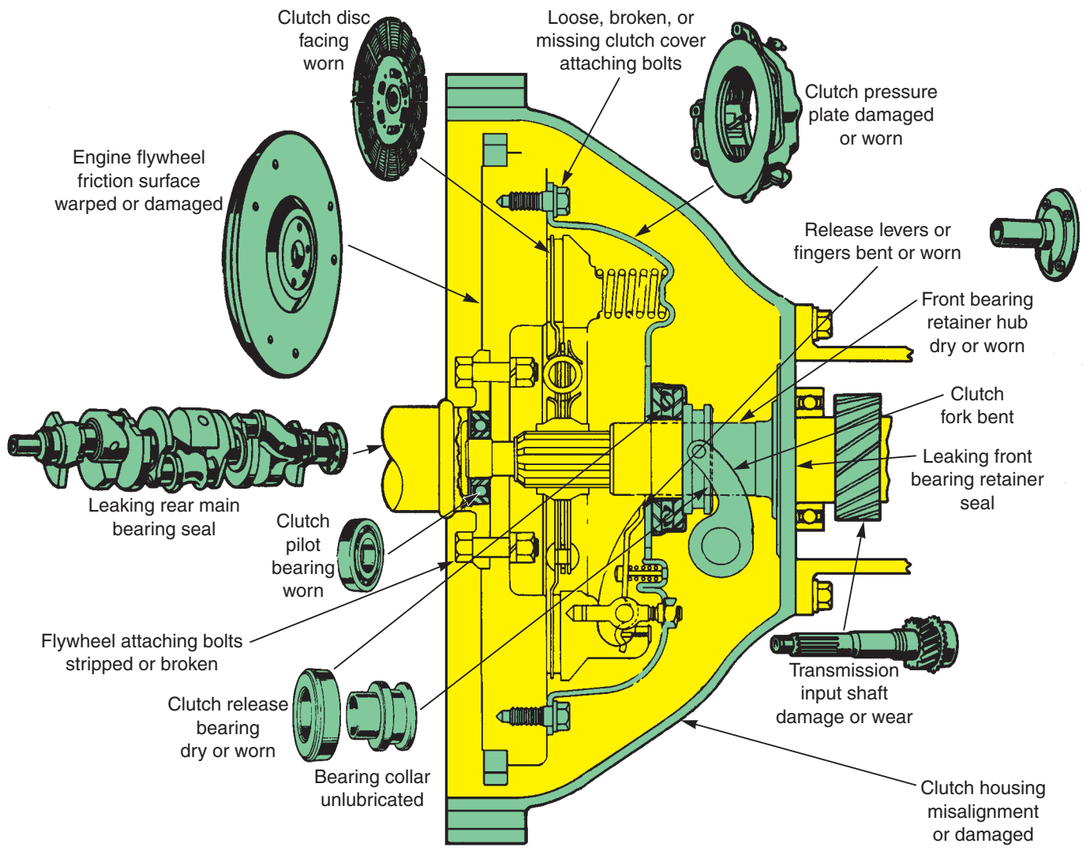

Clutch disc facing worn
Loose, broken, or missing clutch cover attaching bolts
Clutch pressure plate damaged or worn
Engine flywheel friction surface warped or damaged
Release levers or fingers bent or worn
Front bearing retainer hub dry or worn
Clutch fork bent
Leaking front bearing retainer seal
Leaking rear main bearing seal
Clutch pilot bearing worn
Flywheel attaching bolts stripped or broken
Clutch release bearing dry or worn
Bearing collar unlubricated
Transmission input shaft damage or wear
Clutch housing misalignment or damaged

Figure 7-1. *Note typical problems with the clutch assembly. Some defective parts, such as a leaking engine oil seal, are not part of the clutch assembly but can cause clutch problems. It is very unusual for only one part of a clutch to wear out. You should usually replace any clutch part that you suspect is bad. (DaimlerChrysler)*

As stated, clutch problems can occur as a result of careless operation. Driving with a foot resting on the clutch pedal is an example. This careless habit, called ***riding the clutch,*** causes the clutch to slip. As a result, excess heat is generated and premature wearing of clutch friction surfaces occurs. Among the different ways clutches are misused, riding the clutch is the most common. It can put the equivalent of 50,000 miles of normal wear on a clutch in under 10,000 miles.

Naturally, clutch problems can occur as a result of abuse. An example is increasing engine speed and then suddenly releasing the clutch pedal, allowing the pressure plate apply springs to engage the clutch almost instantly. This is often referred to as ***dumping the clutch,*** or ***popping the clutch.*** It causes instant heat buildup in the clutch disc facings and places tremendous stress on the clutch and the entire drive train.

Clutches usually do not last very long under this type of abuse. Overheated clutch facings, a result of dumping the clutch, can become glazed within seconds. This form of abuse can also cause flywheel, clutch cover, or clutch housing attaching bolts to shear off. Further, it can cause clutch disc hub splines to be stripped or input shafts to break.

Placing more load on a clutch than it is designed to handle can also be a source of damage. An example is starting off in high, rather than in low, gear. Shifting into a higher gear before the engine has reached the proper rpm also overloads the clutch, as does attempting to change gears at very high engine speeds. Another example is overloading the vehicle to the point that the clutch must be allowed to slip heavily when starting off, just to get the vehicle moving. This is a common problem on vehicles used for towing.

As stated, outside factors can also cause clutch damage. Oil leaks from the engine rear main bearing seal or from the transmission front bearing retainer seal can reach the clutch disc. If the disc gets contaminated with oil, it grabs or chatters when engaged. If enough oil gets on the disc, it slips at all times and the disc surfaces soon wear out from the resulting friction. If the disc becomes completely saturated with oil, the surface does not wear out, but the disc itself becomes useless.

Finally, many clutch problems are due to lack of maintenance or careless service. If the clutch linkage is not adjusted and lubricated on schedule, or if the throwout bearing or clutch hub splines are not properly greased during installation, the moving parts may hang up or operate slowly. The clutch is subjected to undesirable slippage, shortening its life. Slippage and other problems exhibited in clutch operation are presented in detail in the upcoming paragraphs. **Figure 7-2** summarizes some common conditions and their causes and corrections.

Clutch Drag

If the clutch cannot be disengaged or it fails to release, you cannot shift gears. In this situation, when you stop the vehicle in gear (clutch pedal depressed), the engine stalls. This condition is known as ***clutch drag.***

Clutch drag varies in degree. Slight drag when the clutch pedal is fully depressed may tend to make the car creep when in gear or cause gear clash when the gears are first engaged. The two most common causes of slight drag are improper linkage adjustment and lack of lubrication at the moving parts of the linkage.

In some cases, the car creeps during the clutch spindown, wherein the disc continues to spin for several seconds after being disengaged. To determine if this is causing the creeping and not clutch drag, a simple test can be performed (if the transmission is not fully synchronized). Depress the clutch pedal, shift into Neutral, and wait about 30 seconds. Then, shift into an unsynchronized gear, usually reverse. If the gear engages smoothly, the creeping is caused by spindown, which is normal. If the gear clashes, the creeping is caused by clutch drag. (Consult Chapter 8 for an explanation on synchronizers.)

Clutch drag can be caused by a clutch linkage that is loose, disconnected, or inoperable. The clutch fork inside the clutch housing may be disconnected from the throwout bearing. A hydraulic linkage may be low on fluid—the reservoir may be empty, or the cylinders or lines may be leaking. There might be air in the system. A disconnected linkage or clutch fork or a dry hydraulic system is characterized by a pedal that requires little, if any, effort to depress. A spongy pedal is the result of air in a hydraulic linkage.

Another possible cause of clutch drag is misalignment of the transmission or clutch housing. This can happen as a result of loose bolts or as a result of debris between the mounting faces. Misalignment can cause the linkage or internal clutch parts to stick temporarily. Pedal effort will be normal or higher than normal.

Clutch drag can also be caused by a worn or frozen pilot bearing, a sticking or warped clutch disc, or a warped pressure plate or flywheel. A worn disc may become so overheated, it welds itself to the pressure plate. When these defects occur, the clutch linkage is working properly but the engine and transmission remain mechanically connected.

One of the most common causes of a dragging clutch is too much pedal free travel. With excessive free travel, the pressure plate may back off somewhat, but it will still retain contact with the disc when the pedal is pushed to the floor. Always check the clutch linkage adjustment when indications point to a dragging clutch.

Clutch Slippage

Clutch slippage is a condition wherein the full power of the engine does not reach the transmission. The engine

Clutch Trouble Diagnosis

Condition	Probable Cause	Correction
Fails to Release (Pedal pressed to floor. Shift lever does not move freely in and out of reverse gear.	a. Improper linkage adjustment. b. Improper pedal travel. c. Loose linkage. d. Faulty pilot bearing. e. Faulty driven disc. f. Fork off ball stud. g. Clutch disc hub binding on clutch gear spline. h. Clutch disc warped or bent. i. Loose pivot rings in cover assembly.	a. Adjust linkage. b. Trim bumper stop and adjust linkage. c. Replace as necessary. d. Replace bearing. e. Replace disc. f. Install fork onto stud. Lightly lubricate fingers at release bearing. Also lube bearing I.D. groove. g. Repair or replace clutch gear and/or disc. h. Replace disc (runout should not exceed 0.020″). i. Replace plate and cover assembly.
Slipping	a. Improve adjustment (no lash). b. Oil soaked driven disc. c. Worn facing or facing torn from disc. d. Warped pressure plate or flywheel. e. Weak diaphragm spring. f. Driven plate not seated in. g. Driven plate overheated.	a. Adjust linkage to spec. b. Install new disc and correct leak at its source. c. Replace disc. d. Replace pressure plate or flywheel. e. Replace pressure plate. (Be sure lash is checked before replacing plate.) f. Make 30 to 40 normal starts. CAUTION: Do Not Overheat. g. Allow to cool–check lash.
Grabbing or Chattering	a. Oil on facing. Burned or glazed facings. b. Worn splines on clutch gear. c. Loose engine mountings. d. Warped pressure plate or flywheel. e. Burned or smeared resin on flywheel or pressure plate.	a. Install new disc and correct leak. b. Replace transmission clutch gear. c. Tighten or replace mountings. d. Replace pressure plate or flywheel. e. Sand off if superficial, replace burned or heat checked parts.
Rattling-Transmission Click	a. Weak retracting springs. b. Release fork loose on ball stud or in bearing groove. c. Oil in driven plate damper. d. Driven plate damper spring failure.	a. Replace pressure plate. b. Check ball stud and retainer. c. Replace driven disc. d. Replace driven disc.
Throwout Bearing Noise with Clutch Fully Engaged	a. Improper adjustment. No lash. b. Release bearing binding on transmission bearing retainer. c. Insufficient tension between clutch fork spring and ball stud. d. Fork improperly installed. e. Weak linkage return spring.	a. Adjust linkage. b. Clean, relubricate, check for burrs, nicks, etc. c. Replace fork. d. Install properly. e. Replace spring.
Noisy	a. Worn release bearing. b. Fork off ball stud (heavy clicking). c. Pilot bearing loose in crankshaft.	a. Replace bearing. b. Install properly and lubricate fork fingers at bearing. c. See Section 6 for bearing fits.
Pedal Stays on Floor When Released	a. Bind in linkage or release bearing. b. Springs weak in pressure plate. c. Springs being over traveled.	a. Lubricate and free up linkage and release bearing. b. Replace pressure plate. c. Adjust linkage to get proper lash, be sure proper pedal stop (bumper) is installed.
Hard Pedal Effort	a. Bind in linkage. b. Driven plate worn.	a. Lubricate and free linkage. b. Replace driven plate.

Figure 7-2. *Clutch diagnosis chart. (General Motors)*

speeds up, but the vehicle speed does not increase as it should. The clutch disc is not being gripped firmly, and it slips between the flywheel and pressure plate as the members rotate.

Note: In this section, we are referring to abnormal clutch slippage. For smooth shifts, some degree of slippage is desirable. The clutch pedal should not be released too quickly. A controlled release will permit some slippage. As a result, you will not ruin the clutch or other parts of the drive train. In addition, it makes the ride easier on the vehicle occupants.

Clutch slippage begins as a minor problem. At first, it will occur on initial and hard accelerations. As the problem progresses, slippage will occur on upshifts, downshifts, and on any kind of acceleration. Left uncorrected, slippage only becomes worse. Eventually, the clutch disc becomes so badly worn that there is not enough friction present to move the vehicle.

A slipping clutch gets very hot. The extreme heat damages the contact surfaces of the pressure plate and flywheel, causing them to lose their proper finish. This happens because the heat changes the chemical makeup of the metal, reducing its strength and heat absorption capability. A slipping clutch should be repaired before the pressure plate or flywheel is damaged by excessive heat.

A badly slipping clutch is usually too glazed and worn down to be fixed by adjustment. A clutch disc that is too glazed cannot develop any driving friction between itself and the flywheel and pressure plate. If the clutch disc is completely worn down, the apply springs will not be able to apply enough pressure to the pressure plate to hold it tight against the flywheel. The clutch must be replaced.

A clutch disc that is soaked with oil, such as from a leaking rear main bearing seal, will also slip. In this case, the clutch may not be worn down. If the clutch disc is soaked with oil, however, it must be replaced.

A clutch often slips if the vehicle is driven through deep water. This is because water enters the clutch housing and soaks the clutch disc. The clutch will usually work normally after the disc dries.

Slippage can also be caused by disc, pressure plate, or flywheel contact surfaces that are warped. If the surface is not perfectly flat and straight, the flywheel or pressure plate will not make good contact with the disc. As a result, the disc may slip (or chatter). Warped surfaces may be caused by improper manufacturing processes or by excessive heat.

Sometimes, a clutch slips because the pressure plate apply springs are weak. Weak springs may have been installed in the pressure plate assembly originally, or the assembly may have been intended for a smaller engine or vehicle. The springs may have become weak from overheating, or under normal circumstances, the springs may have become weak because of long usage. A clutch pedal that depresses with almost no effort may be a sign of weak clutch apply springs.

Clutch slippage can be caused by improper clutch linkage adjustment. If the clutch linkage is adjusted to where there is no free play and the throwout bearing is applying pressure to the release levers or fingers, the clutch will not be fully applied, and it will slip.

Note that if the clutch fork return spring is disconnected, the pedal will have no free play. However, this condition will not cause slippage. When the clutch pedal is released after being applied, the apply springs will fully re-engage the clutch. The throwout bearing will ride on the release levers or fingers but will not apply pressure on them to cause slippage. Therefore, do not confuse this condition with the lack of free play caused by misadjustment.

Grabbing Clutch

A ***grabbing clutch*** engages with a jerk or shudder no matter how slowly and carefully it is applied. The effect may be a series of jerks, which is often described as bucking. This problem may be severe enough to cause damage to universal joints or other drive train parts.

If you suspect a grabbing clutch, always check the engine and transmission or transaxle mounts before troubleshooting the clutch. Loose mounts can cause a sensation similar to a grabbing clutch. Also, make sure all clutch housing and transmission bolts are tight.

A grabbing clutch is usually caused by oil deposits disbursed on the friction facing of the clutch disc or by an overly hot or glazed facing. Less common causes are worn splines on the clutch disc hub flange or transmission input shaft, a warped clutch disc, or warped pressure plate or flywheel machined surfaces. Another possible cause is a worn or misaligned clutch fork. This can cause the release bearing to become crooked or tip on its shaft. The result is an uneven application of pressure on the pressure plate assembly. The bearing collar may begin to wear because of the uneven pressure from the fork.

Clutch Chatter

Clutch chatter is a specific type of vibration that is accompanied by a rapid clunking or rattling noise. It occurs while the clutch is being engaged, as opposed to while the clutch is fully engaged. It is closely related to clutch grabbing. It differs, however, in that it is heard more than it is felt. The actual noise is caused not by the clutch, but by the vibration set up in the clutch linkage and drive train. Chatter can be caused by loose or misaligned drive train components. For example, the transmission and clutch housing may be seriously misaligned.

Often, what seems like clutch chatter is really a worn out constant-velocity joint or other universal joint. Other causes of chatter include a misaligned flywheel, a worn pilot bearing, or both. It is possible that release levers are unevenly adjusted or worn. Sometimes, dust from a worn clutch disc facing clogs the disc segments and cause chatter.

Clutch Vibration

Some clutch defects can result in a vibration that can be felt inside of the vehicle while the clutch is fully engaged. This ***clutch vibration*** varies with engine speed. It differs from chatter, which occurs when the clutch is in the process of being engaged or disengaged. Often, clutch vibration is accompanied by noise; however, the noise is a secondary symptom.

Several checks must be made to find the source of the vibration. This is to determine if the problem is clutch vibration or vibration from another source.

Vibration with the vehicle moving may be caused by the engine or any part of the drive train. To narrow down the possibilities, determine when the problem occurs. If the vibration occurs only when the vehicle is moving, the problem is probably not clutch related. Even so, you should check the bolts that secure the clutch housing to the engine and to the transmission just to make sure they are not loose. Thoroughly check the drive shaft assembly, drive axles, and engine mounts. Closely inspect conventional or constant-velocity joints for any signs of wear. In rare cases, internal problems in the transmission or differential or the transaxle may cause vibration while the vehicle is moving. (Refer to later chapters related to these components.)

If the vibration also occurs with the vehicle stopped (transmission in Neutral), the source of the problem is related to the clutch or the engine. Check the engine for a dead cylinder or other internal problem. Vibration resulting from excessive crankshaft endplay can be identified by disengaging the clutch. Pressure from the throwout bearing will push the flywheel and crankshaft forward, taking up the endplay and eliminating any corresponding vibration.

If the engine is okay, look for problems indirectly related to the clutch. First, however, check the clutch housing where it attaches to the engine and to the transmission. Check the front bearing retainer where it attaches to the transmission. Ensure all bolts are tight, **Figure 7-3**. Look at the transmission front bearing as a possible cause of vibration.

Inspect the clutch assembly if the previously mentioned checkpoints have failed to identify the source of vibration. There are two general sources of clutch vibration:

- A part associated with the clutch assembly is out of balance. The parts that are heavy enough to be seriously unbalanced are the flywheel and pressure plate. A balance problem is often found after new parts are installed or the flywheel is resurfaced. The chance of a flywheel or pressure plate becoming seriously unbalanced after long use is slight.
- A part associated with the clutch assembly is loose or broken. Check attaching bolts of the clutch assembly. The flywheel attaching bolts (flywheel-to-crankshaft bolts) may be loose on the crankshaft, or there may be dirt or metal burrs between the crankshaft flange and flywheel. This causes misalignment of the flywheel. When this happens, the clutch usually has other symptoms. The clutch may slip or make a knocking noise.

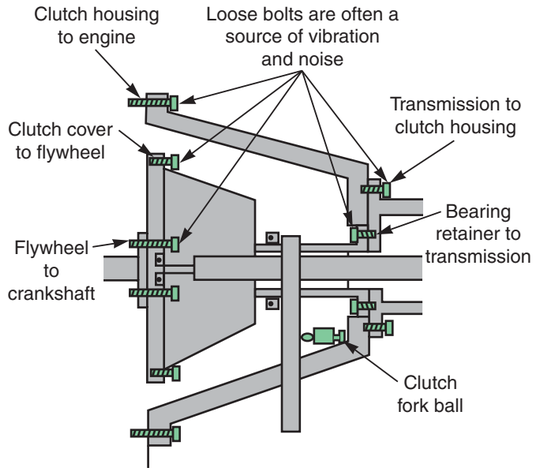

Clutch housing to engine
Loose bolts are often a source of vibration and noise
Transmission to clutch housing
Clutch cover to flywheel
Bearing retainer to transmission
Flywheel to crankshaft
Clutch fork ball

Figure 7-3. *Note places where bolts can loosen, causing vibration (and noise). Often, bolts can be tightened to solve the problem. Occasionally, the vibration will damage other parts before the bolts are tightened.*

Clutch Explosion

A clutch explosion occurs when clutch components fly apart due to centrifugal force. Major causes of clutch explosions are excessive clutch rpm, severely unbalanced components, and loose pressure plate fasteners. A clutch explosion destroys all clutch components and often breaks the clutch housing. A clutch used for racing will often have a scatter shield installed over the clutch housing. This keeps flying clutch components from entering the passenger compartment.

Abnormal Noise

Often, the clutch is blamed for a noise when some other component is at fault. Any vehicle component can become noisy under the right conditions. An abnormal noise in the clutch can usually be singled out by applying or releasing the clutch pedal. If the clutch is the source of the noise, this will have some effect on the noise being made.

Rumbling, squealing, whirring, or grinding noises can be caused by a defective transmission front bearing, throwout bearing, or pilot bearing. A defective transmission front bearing will commonly make noise as the clutch drives the input shaft, whenever the clutch is engaged. A defective throwout bearing makes noise as the bearing is applied. A noisy pilot bearing is usually heard when the clutch is disengaged completely. It will not usually make noise when the clutch is engaged, since the crankshaft and input shaft are turning at the same speed, **Figure 7-4.**

Follow these procedures to isolate defective bearings:

1. While depressing the clutch pedal, start the engine and leave it running. With the transmission in Neutral, release the clutch pedal, taking your foot completely off the pedal. Any noise that you hear upon engaging the clutch will likely be coming from the transmission front bearing.

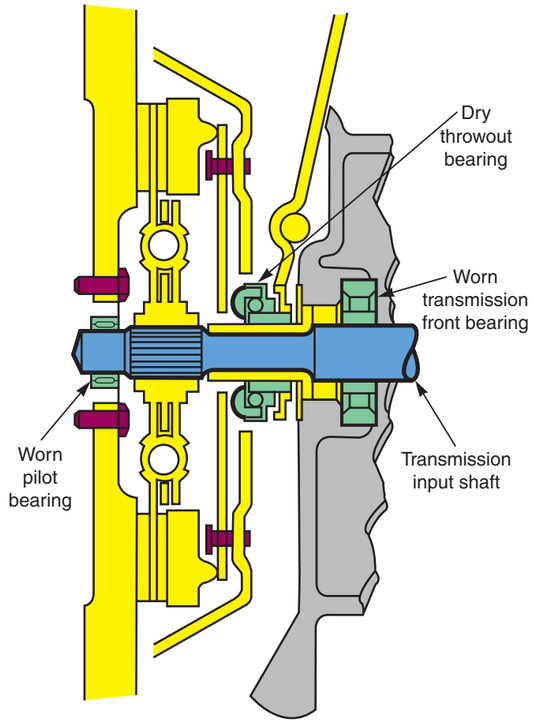


Figure 7-4. *Three bearings associated with the clutch are the pilot bearing, the throwout bearing, and the transmission front bearing. Each can be detected as a source of noise by operating the clutch pedal. Wear or lack of lubrication can cause the bearings to make noise. (Luk)*

2. Push the clutch pedal *only* until all free play is removed. This causes contact with the release levers or fingers, allowing the throwout bearing to rotate without disengaging the clutch. If you hear a noise in this position, typically a whirring or grinding sound, the throwout bearing is probably defective.
3. Push the clutch pedal to the floor. If a noise—typically, a squealing or howling sound—occurs on disengagement, the pilot bearing is probably defective.

Sometimes, the clutch assembly will have a rattle, especially when the clutch is fully engaged and there is no foot pressure acting on the linkage. A possible source of the rattle is a clutch fork that is loose on its pivot ball. The rattle may be caused by too much clearance between the fork and the groove in the throwout bearing. A loose fit between parts of a rod-and-lever linkage or a missing tension spring can cause the mechanism to rattle. It may be possible to tighten the clutch fork retainer clips or springs to reduce clearances and quiet the linkage.

Rattles can also be caused by weak pressure plate retracting springs in the diaphragm-spring pressure plate assembly, or by weak or broken clutch disc cushion springs. Rattles stemming from these problems are usually loudest when the clutch is disengaged.

Loose flywheel attaching bolts cause movement at the mounting surfaces of the crankshaft and flywheel. This movement causes a deep knocking noise that is often mistaken for an engine main bearing or rod bearing knock. The noise may be accompanied by vibration. It can usually be reduced by disengaging the clutch. Pressure from the throwout bearing, acting through the release levers or fingers and the clutch cover, press the flywheel tightly against the crankshaft, quieting the knock.

Hard Pedal Effort

Hard pedal effort is noticed when the clutch pedal is excessively hard to push down. If the pedal is hard to depress, the problem is usually in the linkage. If the driver is strong enough to depress the pedal, it may stay on the floor or rise very slowly when released. Components may wear quickly.

To isolate the cause of the problem, disconnect the clutch linkage at the clutch fork and try to move the pedal by hand. If the clutch pedal does not move easily, the problem is somewhere in the linkage.

Where rod-and-lever linkages are concerned, hard pedal effort is due to lack of lubrication or to some part of the linkage that is bent or loose enough to jam. Sometimes, a rock or other material gets thrown up and jams the linkage.

Clutch pedals of cable linkages usually are hard to depress because moisture has entered the cable sheath. Moisture washes out the cable lubricant and causes corrosion. It is also possible that the cable was misrouted during installation and needs rerouting. If the cable is kinked as a result of misrouting, it should be replaced.

Clutch pedals of hydraulic linkages are hard to depress because of master cylinder or slave cylinder problems. The piston sometimes sticks due to internal corrosion. The usual cause, however, is swollen piston seals. This problem is a result of using a petroleum-based oil, such as automatic transmission fluid, instead of brake fluid (DOT 3 or DOT 4) to refill the reservoir. Petroleum-based oils will cause the seals to swell, jamming the piston in the cylinder. When this occurs, the seals must be replaced.

A less common cause of hard pedal effort in a hydraulic system is a swollen hydraulic hose. If the hose swells so that the fluid passageway becomes fairly constricted, it will take longer to actuate the slave cylinder piston. The swollen hose will slow clutch disengagement. It will also slow clutch reengagement and pedal return.

If the clutch linkage worked as it should when it was disconnected—that is, if it moved easily—the problem is in the clutch assembly. The two most common causes are a throwout bearing collar that is sticking on its hub or binding in the clutch fork. This usually occurs after the vehicle has been operated in deep water, causing water to enter the clutch housing and wash off the lubricant.

If the pedal is very hard to work after a new pressure plate assembly is installed, the pressure plate apply springs may be stronger than necessary. This is very common when a heavy-duty or competition (racing) pressure plate is installed. Return springs that are too heavy might be responsible for hard pedal effort. Remember, as you depress the clutch pedal, you are working against return-spring tension.

In-Car Clutch Service

Clutch service commonly requires the removal of major components, such as the drive shaft assembly, transmission, and clutch assembly. However, certain clutch problems can be attended to without removing these major components. This type of service is categorized as ***in-car service.*** Clutch repairs that fall into this category are clutch adjustment and linkage repair or replacement. Procedures are given in this section.

Clutch Adjustment

Clutch adjustment involves setting the correct amount of free play in the clutch linkage. Too much free play can cause clutch drag, preventing the clutch from ever fully disengaging. In this case, the power flow is not completely cut off from the clutch and the engine could continue to propel the vehicle. Too little free play can cause the clutch to slip. In this case, the throwout bearing rotates continually as it contacts the rotating pressure plate release levers or fingers, and it quickly wears out. With enough pressure on the levers or fingers, the clutch slips, overheats, and becomes damaged.

No matter what type of clutch linkage is used, the free play can be checked by pushing the clutch pedal with your hand. Refer to **Figure 7-5** and the next few paragraphs for the proper procedure.

Begin with the pedal in a fully released position—that is, with the pedal all the way up. Start pushing down on the pedal. The pedal should move easily for about 1″ (25 mm). In this span, the only pressure you are working against is that of the return springs. Past this point, the pedal becomes harder to push. This is where the throwout bearing contacts the pressure plate release levers or fingers, and you are working against the force of the pressure plate apply springs.

The distance that the pedal moved from the fully released position until it became hard to push is the free play. All vehicle manufacturers specify the proper amount of clutch free play. Free play is adjusted at some place on the clutch linkage. On many vehicles, the clutch has a self-adjusting feature that automatically adjusts free play whenever the clutch pedal is depressed.

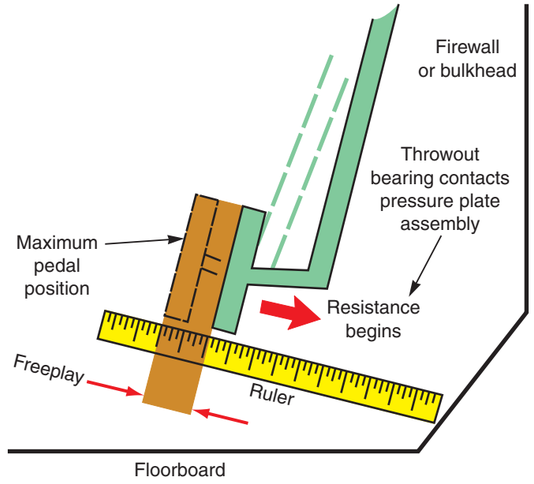


Figure 7-5. *Free play can be measured using a ruler. The amount of free play should match the manufacturer's specifications. A general check can be made by observing the pedal movement. The throwout bearing first contacts the pressure plate assembly at the point where resistance is first felt when pressing on the pedal.*

Note: A slipping clutch that is badly worn or damaged cannot be repaired by adjustment. If adjustment does not stop clutch slipping, or if enough free play cannot be obtained (indicating worn parts), the clutch assembly must be removed and worn parts must be replaced.

Rod-and-lever linkage adjustment

A rod-and-lever linkage is a series of links, levers, and rods connecting the clutch pedal to the clutch fork. Adjustment is usually provided by a threaded rod that passes through a pivot block, **Figure 7-6** and **Figure 7-7.** An adjustment device is located on the linkage at the clutch fork.

To adjust a rod-and-lever linkage, measure the actual amount of free play at the clutch pedal and compare it to specifications. Use a ruler to make an accurate measurement. If the specifications are not available, 1″ (25 mm) of free play is usually close. Before attempting to make the adjustment, check that the linkage is not worn excessively. A loose, sloppy linkage cannot be satisfactorily adjusted.

Next, for the single-locknut adjuster, loosen the locknut that holds the threaded rod to the pivot block. Turn the rod until the proper free play is obtained at the clutch pedal and then retighten the locknut. For the double-locknut adjuster, loosen the one locknut, depending on which way the adjustment is to be made. Then, turn the other locknut in the same direction, advancing the pushrod until

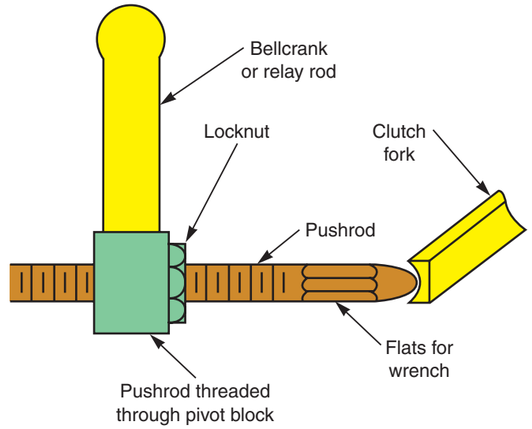


Figure 7-6. *This shows a single-locknut adjuster. The locknut is loosened and the pushrod is turned in or out to obtain the proper free play.*

the proper free play is obtained at the clutch pedal. Retighten the first locknut. Recheck the free play at the clutch pedal. As a final check, road test the car to check clutch operation.

Cable linkage adjustment

The cable linkage uses a cable to connect the clutch pedal to the clutch fork. Adjustment is made by a threaded section, which passes through a bracket. This section is located on the end of the cable linkage at the clutch fork. See **Figure 7-8.**

Some cables are self-adjusting. If there is no free play on a self-adjusting clutch, the adjustment mechanism is faulty or

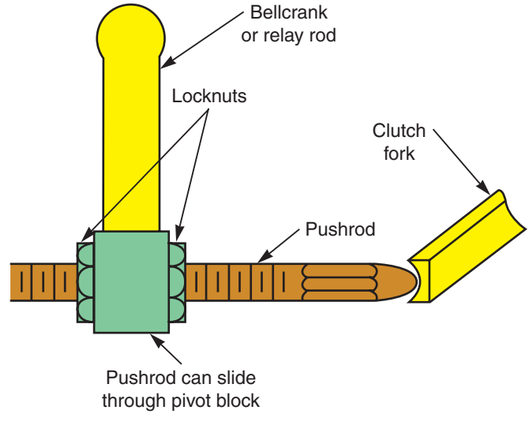


Figure 7-7. *This shows a double-locknut adjuster. One locknut is backed away, the other is turned in the same direction to adjust the pushrod length. Note that the pushrod slides through the hole in the pivot block.*

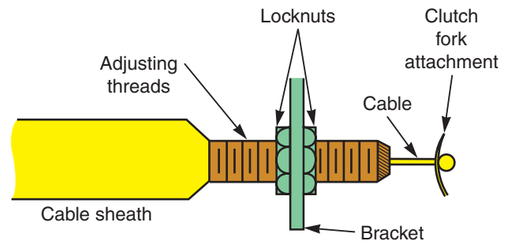


Figure 7-8. *Adjusting free play in a cable linkage. The end of the cable is threaded. Loosening the locknuts and moving the cable makes the adjustment.*

the clutch is worn out. Note that in many vehicles with self-adjusting clutch systems, the throwout bearing is always in contact with the release levers or fingers. Such bearings are called ***constant-duty throwout bearings.*** With the clutch pedal fully released, the bearing makes light contact with the release levers or fingers. Even so, there is enough slack in the cable linkage to give some free play at the pedal.

If the clutch is the manually adjustable type, use a ruler to measure the actual amount of free play at the clutch pedal. Compare the amount against the manufacturer's specifications. If the specs are not available, you can assume that the free play is between 1″ and 1.5″ (25 mm and 38 mm). Also, check that the cable and other linkage work freely and do not bind.

If the free play must be adjusted, loosen the locknut holding the threaded portion of the cable sheath. There are usually two locknuts holding the end of the cable to a bracket. Leave the locknuts loose and alternately turn them until the cable length is correct. Tighten the locknuts and recheck the free play at the clutch pedal. Then, road test the car and check clutch operation.

Hydraulic linkage adjustment

The hydraulic linkage uses hydraulic pressure to transfer pedal movement to the clutch fork. As with the previous adjusters, adjustment is made by a threaded section on the linkage at the clutch fork. Adjustment to this linkage changes the effective length of the pushrod at the slave cylinder. See **Figure 7-9.**

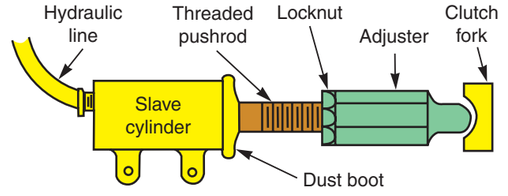


Figure 7-9. *Adjusting free play in a hydraulic linkage. The pushrod is often threaded. Shortening or lengthening the rod adjusts free play. The pushrod is held by a locknut.*

Measure the amount of free play at the clutch pedal. Use a ruler to obtain an accurate reading, and compare it against specifications. If the specifications are not available, between 1″ and 1.5″ (25 mm and 38 mm) of free play is generally acceptable.

Before adjusting free play, check the master cylinder reservoir to make sure the fluid level is sufficient. Add DOT 3 brake fluid if necessary.

Caution: *Never* add motor oil, transmission fluid, or any kind of petroleum-based oil to the master cylinder reservoir. Use brake fluid only to prevent major damage to seals!

Loosen the locknut holding the threaded rod to the adjuster. Turn the rod until you obtain the proper free play as measured at the clutch pedal. Retighten the locknut. Recheck the free play at the clutch pedal. Then, road test the car.

Clutch Linkage Repair and Replacement

Check the clutch linkage for proper operation. One of the most common points of wear in the linkage is the pedal itself. Bushings can wear, or the mounting bracket bolts can loosen. Always check these parts when servicing the clutch linkage or overhauling a clutch. **Figure 7-10** shows typical clutch pedal components.

Rod-and-lever linkage

A rod-and-lever linkage usually wears at pivot points. See **Figure 7-11.** Many pivot points contain metal or plastic bushings. These bushings often wear out.

Sometimes, linkage rods or levers will bend. This may happen if something in the clutch causes excessive resistance in disengagement. Another common cause of problems is a bellcrank that binds or is loose because of worn motor mounts or misalignment of the engine in the vehicle. The linkage must be restored to perfect operating condition before the clutch will operate properly. This may involve lubrication, adjustment, or replacement of linkage parts.

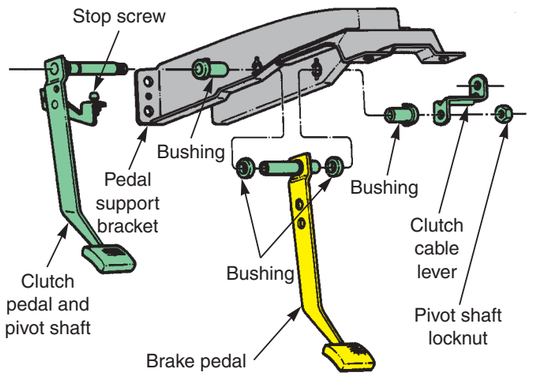


Figure 7-10. *Study the exploded view of a typical clutch and brake pedal assembly. The pivot points should be carefully checked and lubricated. (DaimlerChrysler)*

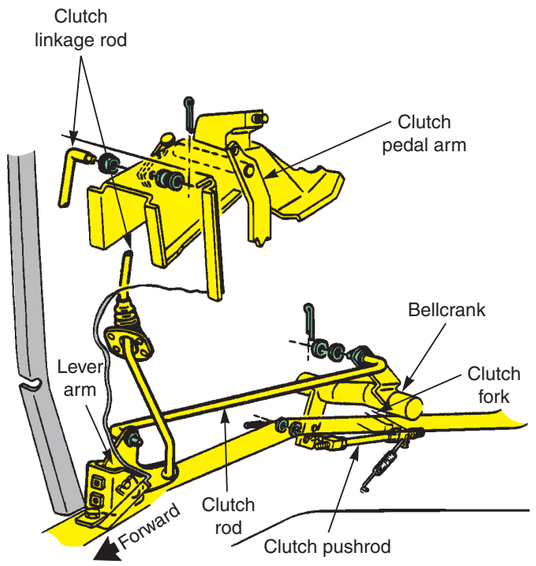


Figure 7-11. *Notice the pivot points in this exploded view of a rod-and-lever linkage. Most problems in this system are caused by wear, misadjustment, or lack of lubrication at the pivot points. (General Motors)*

Cable linkage

Cable linkage problems are usually due to a seized or binding cable assembly. Cables can seize due to corrosion or lack of lubrication. A cable may seize or bind if it is caused to kink in its sheath from improper routing. Defective cables should be replaced.

If a cable must be replaced, make sure you route it so there is no possibility of seizing or binding. Use all the original cable brackets and mounting locations if possible. A typical cable arrangement is shown in **Figure 7-12.**

Hydraulic linkage

Before adjusting a hydraulic linkage, always check the fluid level in the master cylinder reservoir first. If the fluid level is low, check for leaks at the places indicated in **Figure 7-13.** Leaks appear as dark stains on hydraulic system parts. Sometimes the brake fluid used in the system is visible at the point of the leak. Leaks can occur in the hydraulic lines or at loose connections. The most common leaks, however, occur at the master or slave cylinder seals.

It is usually easier and cheaper to replace leaking master and slave cylinders. However, in some cases, a

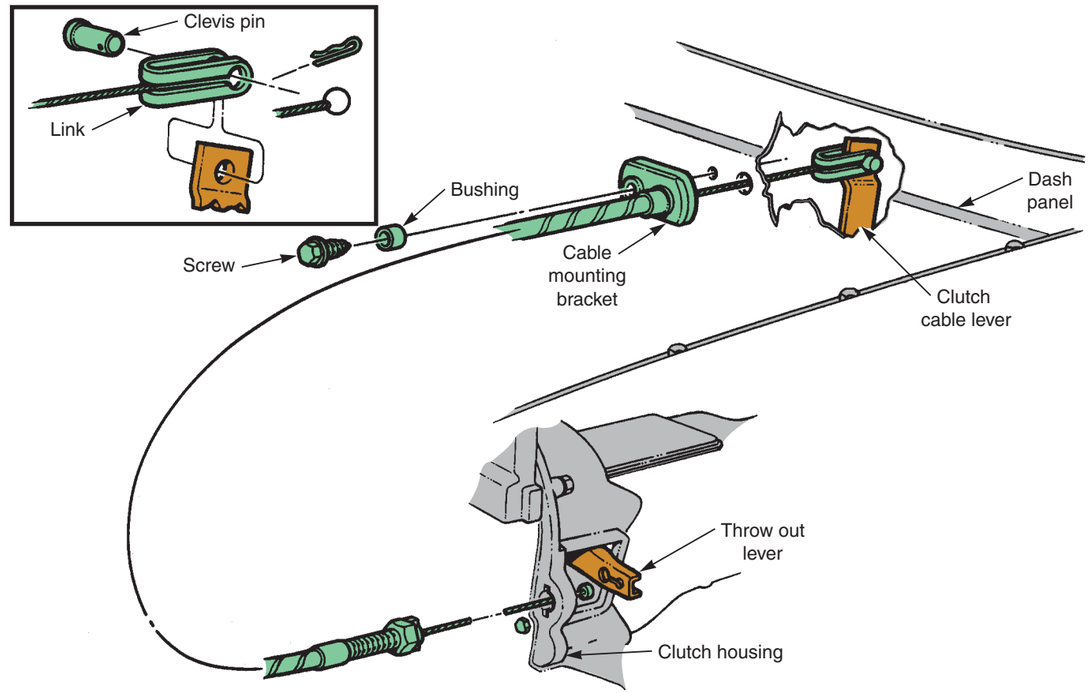


Figure 7-12. *This is a typical cable linkage. A replacement cable must be routed so that it does not seize or bind. The original routing is normally the best. (DaimlerChrysler)*

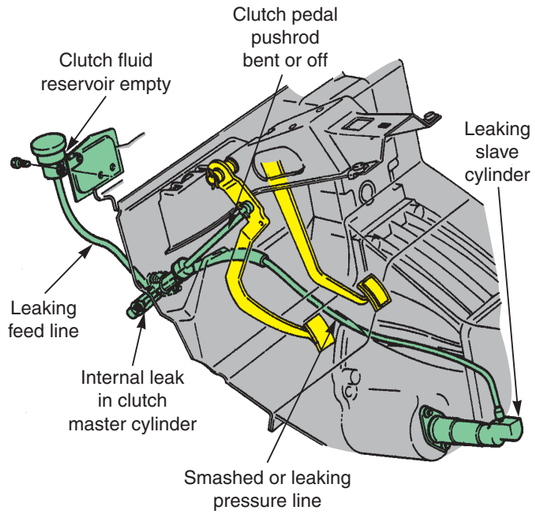

Clutch pedal pushrod bent or off
Clutch fluid reservoir empty
Leaking slave cylinder
Leaking feed line
Internal leak in clutch master cylinder
Smashed or leaking pressure line

Figure 7-13. *Common sources of hydraulic linkage problems are shown. The pushrod for actuating the master cylinder piston may be bent or disconnected, but most problems are caused by low fluid level or by plugged hydraulic lines. Leaks are usually responsible for low fluid levels. Kinks can cause plugging of hydraulic lines. (Ford)*

replacement cylinder is not available, or the cost of replacement is excessive. If a new or remanufactured master or slave cylinder cannot be located, the old cylinder can be rebuilt with the proper seal kit.

Rebuilding a master or slave cylinder is relatively simple. It is similar to rebuilding brake system cylinders. Refer to the exploded views of typical master and slave cylinders in **Figure 7-14.** Following is a typical rebuilding procedure:

1. Remove any rubber boot that covers the free end of the piston.
2. Remove the snap ring that holds the piston in the cylinder bore. The piston should slide out of the cylinder. In some cases, the piston will pop out of the cylinder because of a return spring behind it. If the piston is stuck, it can be removed by tapping the cylinder on a wooden block or by carefully applying air pressure to the inlet connection.

Warning: Air pressure can cause the piston to fly out with great force. Point the open end of the cylinder away from yourself and others and toward rags or some other soft surface before applying pressure.

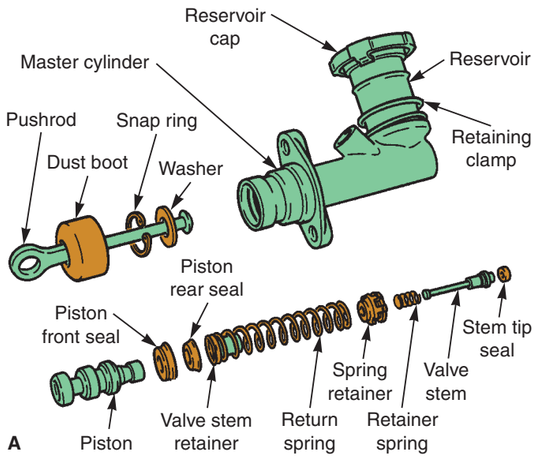


Figure 7-14. *Study the exploded views of master and slave cylinders. A—A master cylinder is shown. The shape, the included parts, and their layout can vary. The manufacturer's service manual should be consulted for an exact breakdown of parts. B—A slave cylinder is shown. It, too, can vary as to parts, shape, and layout. (DaimlerChrysler, General Motors)*

3. Once the piston is out, inspect the cylinder for wear or pitting. If the cylinder bore is worn or pitted, the cylinder must be replaced. Remove the old seals from the piston and discard them. Thoroughly clean all parts and allow them to dry.

Caution: Do not allow any petroleum-based solvent to remain on the cylinder or piston.

4. Install the return spring, when there is one, in the cylinder.
5. Obtain new seals. Make sure they are the correct ones. Lubricate them with brake fluid, *never* with petroleum-based lubricants, and install them on the piston.
6. Install the piston in the cylinder. Be careful not to damage the new seals.
7. Install the retaining snap ring, pushrod, and boot.
8. Install the rebuilt cylinder.
9. Attach the hydraulic line. There should be no air in hydraulic lines; if there is, it must be removed by bleeding the lines. If the hydraulic system was disassembled for any type of repairs, you must bleed the lines to remove the air. Once the bleeding operation is finished, pressure on the pedal should apply the clutch firmly. There should be no spongy-pedal feel.

The slave cylinder has a ***bleeder valve*** for bleeding air from the system. The valve looks like a screw with a small hole running down its length. The hole is closed off when the bleeder valve is tightened down. Loosening the valve a few turns will open the hole and permit system bleeding. Note that some bleeder valves have a cap, as well.

There are two methods to manually bleed air from a hydraulic system. One method is preferred over the other because it minimizes the chance of fluid contamination. This preferred method is outlined as follows:

1. Fill the system reservoir with fresh brake fluid. Leave the cover off the reservoir. (Bleeder valve is closed.)
2. If the bleeder valve has a cap, remove it at this time. Attach a hose to the end of the bleeder valve. Place the free end of the hose in a clear container. Fill the container with enough fluid to cover the bottom of the hose.
3. Have an assistant pump several times on the clutch pedal. Then, ask the assistant to hold the pedal down.
4. Open the bleeder valve by loosening it about a quarter or half turn. Make sure your assistant continues to keep his or her foot on the clutch pedal. The pedal will probably go all the way to the floor. Air, or a mixture of air and brake fluid, will come out of the bleeder valve. Keep the outlet of the hose submerged in the fluid as it begins to fill the container. Watch for air bubbles.
5. Close the bleeder valve once the flow stops.
6. Let up on the clutch pedal.
7. Repeat the process until only brake fluid comes out of the bleeder valve. This can be noted by watching the air bubbles emerging from the hose as the system is bled.
8. Top off the system reservoir with fresh brake fluid, and put the cover back on the reservoir. Do not reuse fluid bled from the system, as it may be contaminated.

There is an alternative method of bleeding air from a hydraulic system. It can be done without an assistant and without wasting brake fluid; however, expelled fluid, which may be contaminated, is returned to the system. The method is outlined as follows:

1. Open the bleeder valve by loosening it about a quarter or half turn.
2. If the bleeder valve has a cap, remove it at this time. Attach a hose to the end of the open bleeder valve. Place the free end of the hose in a clear container of brake fluid.
3. Fill the system reservoir with fresh brake fluid, and replace the cap.
4. Pump the clutch pedal until bubbles stop coming out of the hose in the container. You might want to have an assistant watch for the bubbles for you to make the job easier.
5. With the clutch pedal released, close the bleeder valve.

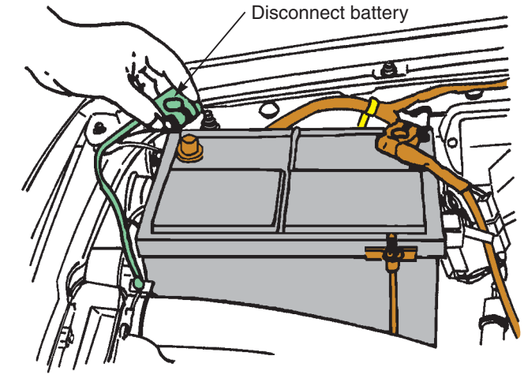


Figure 7-15. *The battery should always be disconnected at the ground terminal before beginning any clutch repairs. If the battery is not disconnected, there is always a possibility that the starter will be operated, causing injury. (Subaru)*

Clutch Removal

The exact procedure for clutch removal varies according to the engine and drive train layout. On vehicles with rear-wheel drive and on many vehicles with front-wheel drive, the transmission and clutch are removed from the vehicle without removing the engine. On some front-wheel drive and on most rear-engine vehicles, the engine, clutch, and transaxle are removed from the vehicle as an assembly. When removed from the car, the components are separated to expose the clutch assembly. On other front-wheel drive vehicles, the engine and clutch are removed, leaving the transaxle in the vehicle. On a few vehicles, the clutch can be removed and replaced without removing any other components.

The following sections contain some general procedures for removing a clutch from a vehicle. Always refer to the appropriate service information for specific procedures.

Front-Engine, Rear-Wheel Drive

The following procedure details the proper way to remove a clutch from a front-engine, rear-wheel drive vehicle:

1. Disconnect the battery negative cable, **Figure 7-15.**

Warning: *Always* disconnect the battery ground cable before working near the clutch. Otherwise, if the starter is accidentally operated, you could be severely injured.

2. Raise the vehicle with an approved hoist or hydraulic jack. If using a hydraulic jack, be sure to install good quality jack stands under the vehicle frame before getting under the vehicle.

Warning: *Never* work under a vehicle supported only by a hydraulic jack. Always support the vehicle with jack stands.

3. Once the vehicle is properly raised and supported, remove the drive shaft assembly. (Chapter 13 covers this in detail.) Cap the rear of the transmission to prevent oil dripping. See **Figure 7-16.** If the vehicle has four-wheel or all wheel drive, remove the front drive shaft from the transfer case.

Warning: If the vehicle has been operated recently, the engine and exhaust system will be hot. *Always* be careful when working on a hot engine.

4. Disconnect the pushrod or cable and return spring connected to the clutch fork.
5. Remove the transmission. (Chapter 9 covers transmission removal in detail.) On many vehicles, the clutch housing and transmission case are combined in a single casting. In such cases, the clutch housing is removed along with the transmission by removing the unit from the back of the engine. Note that the transmission input shaft and front bearing retainer are removed with the transmission. In addition, the clutch fork and throwout bearing assembly are removed with the one-piece, or integral-type, casting. If the vehicle has a transfer case, the transmission and transfer case can be removed as a unit.

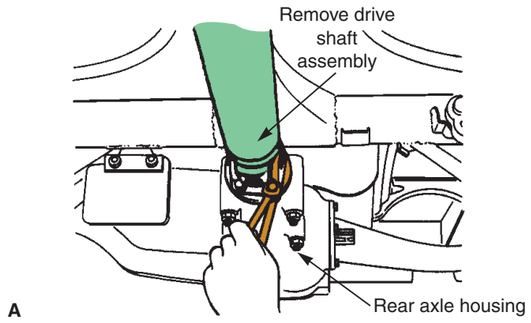


Figure 7-16. *The first steps to remove a clutch. A—Remove the drive shaft assembly. B—Cap the transmission extension housing to prevent oil loss. Oil leakage can create a safety hazard. (Subaru)*

Warning: Support the engine when removing the transmission. Usually, the transmission provides some support for the engine. Removing it removes this support.

Also, use a transmission jack, **Figure 7-17,** to support the transmission. *Never* let the transmission hang unsupported once attaching bolts connecting the transmission to the clutch or engine are removed. This can cause damage to the clutch disc splines or transmission input shaft. Make sure, for this and for other reasons, you support the transmission at all times. If a transmission were to fall, it could cause injury or damage. Be especially careful when lowering a transmission and transfer case combination, as the weight of the transfer case is usually off-center.

6. Remove as much dust as possible from inside the bellhousing with an approved vacuum collection system designed for use with asbestos fibers, in particular.

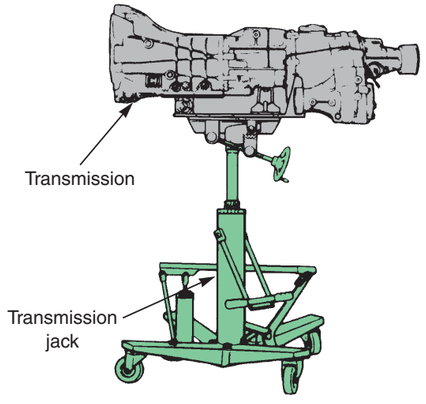


Figure 7-17. *Transmissions are heavy. Use a transmission jack to support and lower the transmission from the vehicle. (Owatonna Tool)*

Warning: Some clutch discs contain asbestos—a powerful cancer-causing substance. Avoid breathing dust from inside the bellhousing or clutch assembly. Do *not* blow dust off these components with compressed air.

7. Remove the throwout bearing from the clutch fork. If the clutch fork pivots on a ball stud, remove the fork at this time. Most clutch forks are held to the ball stud by spring clips. See **Figure 7-18.** In many cases, the clutch fork can be removed by pushing (or pulling) the inner end toward the front of the housing while pulling the other end straight out.
8. If still in place, remove clutch housing from the back of the engine. (Integral-type clutch housing was removed with transmission.) To do this, remove the clutch access cover from the front of the housing. Then, remove the clutch housing attaching bolts (clutch housing-to-engine bolts). Vacuum any dust inside the housing.

   Note that housing removal is not necessary in every case. In some vehicles, the clutch assembly may be removed through an opening provided by removal of a clutch access cover.
9. If the pressure plate assembly and flywheel do not have dowels or offset bolt holes for alignment purposes, use a punch to mark the original position of the clutch cover relative to the flywheel. Beforehand, vacuum any dust from the clutch. Typical punch marks are shown in **Figure 7-19.**
10. Insert a pilot shaft, or clutch alignment tool, through the clutch disc hub and into the pilot bearing, if desired. This will keep the clutch disc from falling out of the pressure plate assembly as the clutch cover attaching bolts (clutch cover-to-flywheel bolts) are being removed. Note that an old transmission input shaft makes a good pilot shaft.

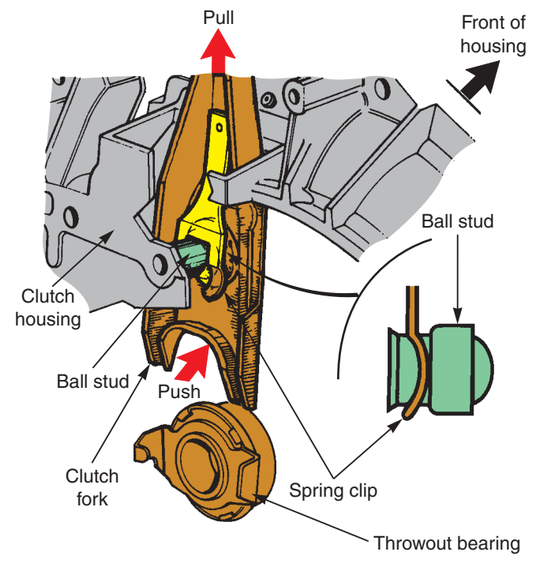


Figure 7-18. *Clutch forks that pivot on a ball stud are usually held in place by a spring clip. Remove the clutch fork by pushing the inner end forward and pulling on the outer end. (DaimlerChrysler)*

11. Loosen the clutch cover attaching bolts sequentially, one turn at a time, until all spring pressure is relieved. If bolts cannot be reached, use a flywheel turner to rotate the flywheel until each bolt is accessible. Once pressure is relieved, carefully remove the bolts and the pressure plate assembly. Then, remove the clutch disc and alignment tool from the flywheel.

Warning: The pressure plate assembly is fairly heavy. Make sure you can support its weight before removing the last bolt. If a clutch alignment tool has not been used, be aware that the clutch disc could fall out as the attaching bolts are removed.

Also, if the clutch was slipping, it may be hot for a long time after the vehicle is stopped. Be careful not to burn yourself on a hot pressure plate or flywheel.

12. With the clutch removed, check the engine-to-transmission mounting surface for cracks and foreign material that would prevent proper engine-transmission mating. Also check the core (freeze) plugs at the rear of the engine block for corrosion, leaks, and proper installation. Check the rear seal for oil leaks and damage. If dowel pins are used for engine and clutch housing alignment, check them for burrs or bending. If there are no dowel pins, ensure that they have not been lost. Check the dowel pin holes for elongation and burrs.

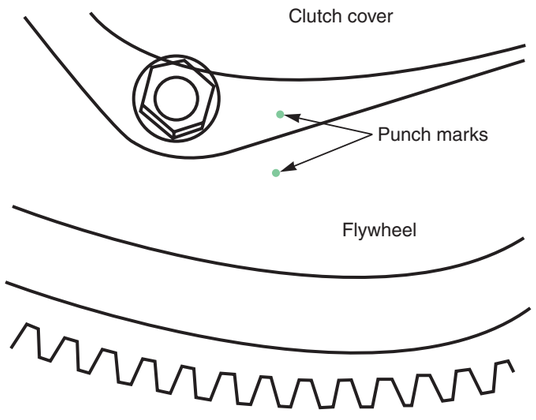


Figure 7-19. *To maintain the proper balance between the reassembled flywheel and the pressure plate assembly, make punch marks on both parts before disassembling. This is necessary only if the pressure plate will be reused.*

In many cases, this completes clutch removal. You should inspect the pilot bearing and flywheel (outlined in upcoming paragraphs) and determine if they must also be removed.

Front-Engine, Front-Wheel Drive

The following procedure details the proper way to remove the clutch from a front-engine, front-wheel drive vehicle. Note that with a few exceptions, the general procedure, cautions, and warnings duplicate clutch removal for front-engine, rear-wheel drive vehicles.

1. Disconnect the battery negative cable.

Warning: *Always* disconnect the battery ground cable before working near the clutch. Otherwise, if the starter is accidentally operated, you could be severely injured.

2. Raise the vehicle with an approved hoist or hydraulic jack. If using a hydraulic jack, be sure to install good quality jack stands under the vehicle frame before getting under the vehicle.

Warning: *Never* work underneath a vehicle supported only by a hydraulic jack. *Always* support the vehicle with jack stands.

3. Once the vehicle is properly raised and supported, remove the drive axles. There are several variations of front drive axle attachment. On some vehicles, the wheels and brake assembly, along with certain steering and suspension parts, must be removed to remove

the axles. On other vehicles, the drive axles can be removed without removing these parts. (This is covered in detail in Chapter 15.)

Warning: If the vehicle has been operated recently, the engine and exhaust system will be hot. *Always* be careful when working on a hot engine.

4. Disconnect the pushrod or cable and return spring connected to the clutch fork.
5. Remove the transaxle. (This is covered in detail in Chapter 11.) On many vehicles, the transaxle and clutch housings are a single unit, **Figure 7-20.** If this is the case, the complete unit is removed from the engine. On vehicles requiring the engine also be removed for clutch replacement, refer to the manufacturer's service manual.

   Note that the transmission input shaft and front bearing retainer will be removed along with the transaxle. In addition, the clutch fork and throwout bearing assembly will be removed with the one-piece, or integral-type, casting.

Warning: Support the engine with an engine holding fixture when removing the transaxle. This will keep the engine from dropping as you remove the transaxle and will protect the motor mounts.

Also, use a transmission jack to support the transaxle. *Never* let the transaxle hang unsupported once attaching bolts connecting the transaxle and clutch housings are removed. This action can cause damage to the clutch disc splines or transmission input shaft. Make sure, for this and other safety reasons, that you support the transaxle at all times. If a transaxle were to fall, it could cause injury or damage.

From here, the clutch removal procedure duplicates that for front-engine, rear-wheel drive vehicles. To complete clutch removal, continue with step 6 of that section.

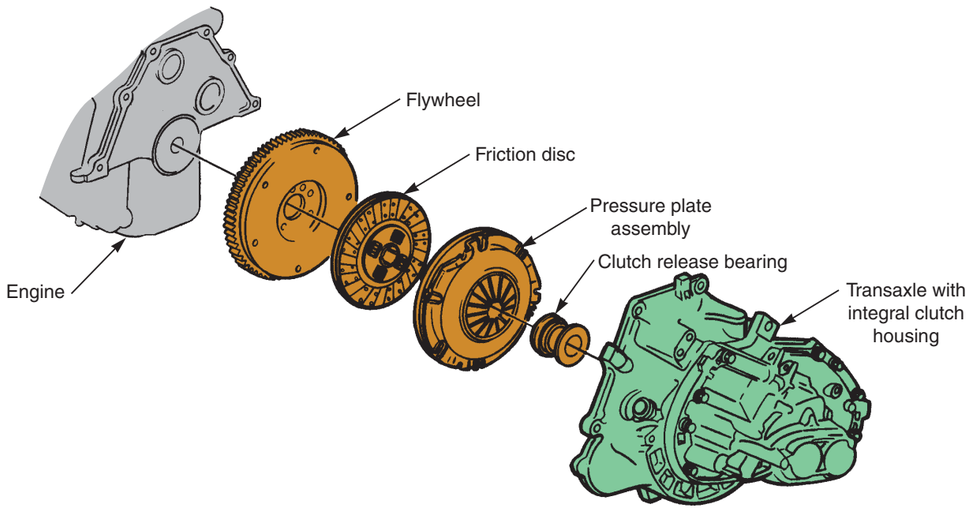


Figure 7-20. *The clutch housing and transaxle case are usually combined into a single casting. (General Motors)*

Clutch Parts Inspection and Repair

With the clutch removed, each component must be carefully inspected for wear and damage. Be sure all parts are clean before inspection. Clean the flywheel face and pressure plate with a nonpetroleum-based cleaner. Do not wash the throwout bearing in any kind of solvent. Do not get grease on the clutch disc facings.

Look for any signs of damage or wear, no matter how slight. After the defect is identified, the concerned part(s) may be repaired or replaced. Service procedures for the various related parts of the clutch are the focus of this section.

Pilot Bearing Service

A worn pilot bearing will allow the transmission input shaft and clutch disc to wobble. This can cause clutch vibration, a noisy clutch, and damage to the transmission. Pilot bearings are relatively cheap, and they are easy to change while the clutch is being serviced.

Bearing inspection

The clutch pilot bearing is not serviced until the clutch is removed. The bearing is often worn out by then. The pilot bearing should be inspected for excessive wear or damage. Some technicians will automatically replace the bearing as a matter of practice. If there is any doubt about a pilot bearing's condition, it should be replaced!

Roller- or ball-type pilot bearings should be inspected for lack of lubrication. To check this, turn the bearing and feel for roughness. If it does not turn smoothly, it should be replaced.

In a pilot bushing, wear will show up as looseness between the bushing and the input shaft pilot. A good way to check for looseness is to insert a used input shaft into the bearing and try to wiggle it. If it has too much play, the bushing is worn out and it should be replaced.

Note: To perform this check, you must have the same type of input shaft as used in the vehicle transmission.

Bearing removal

There are a couple ways to remove a pilot bearing. One way is to use a pilot bearing puller tool, as shown in **Figure 7-21.** One variation of this tool is the threaded-tip puller. The threaded-tip puller is used to remove a pilot bushing, but it ruins the bearing in the process. The center shaft, or pilot, of this tool has a self-tapping tip. The pilot is threaded into the bore of the bearing. When fully inserted, the legs of the puller are adjusted to seat on the crankshaft flange. As the tool is tightened further, it pulls the pilot bearing from the crankshaft bore. Another variation, called an expandable finger-tip puller, is a similar tool used when ball or roller bearings are used.

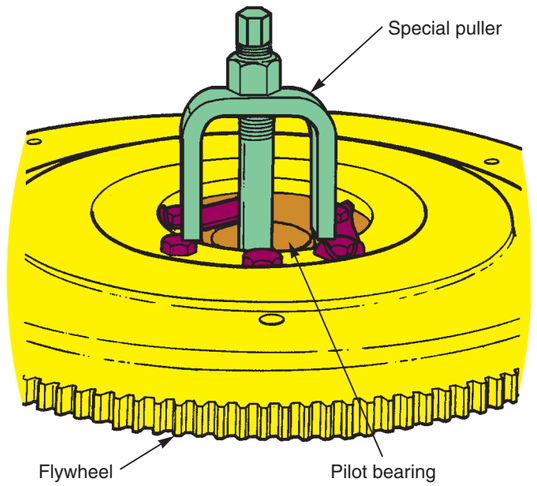


Figure 7-21. *The pilot bearing removal tool will make pilot bearing removal easier. (DaimlerChrysler)*

Another way to remove the old pilot bearing is to pack the recess behind the bearing with heavy grease. Then, install a driver into the pilot bearing—an old input shaft works nicely. Put on eye protection and strike the exposed end of the input shaft with a hammer. The force from the hammer will travel through the input shaft to the grease. The grease will push the bearing from the crankshaft. See **Figure 7-22.**

Bearing installation

Before installing the new pilot bearing, slip it over the pilot of the transmission input shaft. This is done to ensure it is the proper bearing. If it will not slip over the shaft, or if the fit is too loose, it is not the correct bearing.

The next step is to drive the new bearing into the crankshaft bore, **Figure 7-23.** Use a properly sized driver to avoid damage. Measure the installed depth of the pilot bearing. If this depth is too shallow, the input shaft may contact the bearing. This will damage the bearing, the input shaft, or both. If the bearing is driven in too deeply, it may not make full contact with the input shaft pilot. This is not a problem with bushings, as they are usually longer. If bushings are driven in too deeply, there is still usually adequate surface contact with the input shaft pilot.

Once the pilot bearing is properly installed, lubricate it with a small quantity of high-temperature grease. Most bearings have a recess behind the bearing. A small amount of grease stored in this recess will find its way to the bearing surface, helping to keep it supplied with lubricant. See **Figure 7-24.**

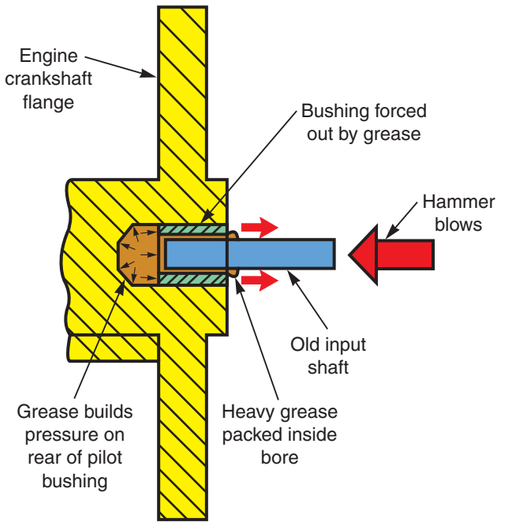

Engine crankshaft flange
Bushing forced out by grease
Hammer blows
Old input shaft
Grease builds pressure on rear of pilot bushing
Heavy grease packed inside bore

Figure 7-22. *A pilot bearing can also be removed by packing grease into the recess behind the bearing. A driver is then placed into the pilot hole and struck. The driver moves into the grease, creating pressure. The pressure drives out the bearing.*

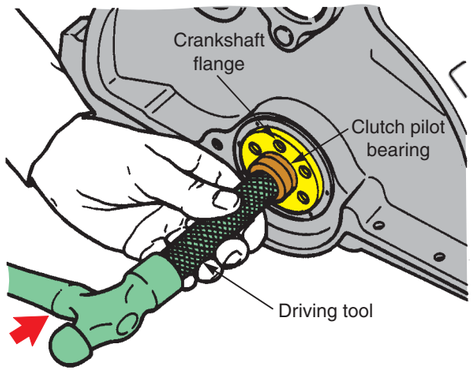


Figure 7-23. *A new pilot bearing should be installed with the proper bearing driver. Use a driver that contacts the outer race only when driving a roller- or ball-type pilot bearing. Always be very careful to avoid damage when installing a new bearing. (Ford)*

Caution: Do *not* put too much lubricant on the bearing or in the recess. Excess lubricant will be thrown out of the pilot bearing and can ruin the clutch disc. Note that some bearings are prelubricated and do not require any additional lubrication.

Flywheel Service

The flywheel is large and very heavy, and removing it can be difficult and even dangerous. It should not be removed unless it is in need of resurfacing. It is rare to find a flywheel that is not showing some sign of wear or overheating. Judgment is called for in deciding if it must be resurfaced. In many cases, the flywheel can be reused without machining. If the flywheel is not badly worn, it can be cleaned by light sanding.

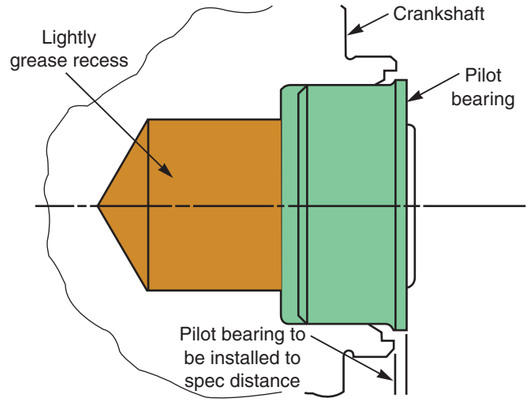


Figure 7-24. *Grease the recess behind the pilot bearing, but be careful to use only a small amount. Lack of grease will allow the bearing to run dry and be damaged. On the other hand, too much grease will drip out and damage the clutch disc. (Ford)*

Flywheel inspection

Visually inspect the flywheel for obvious signs of damage. Check the flywheel machined surface for discoloration (caused by overheating), scoring, or extremely shiny surfaces. In some cases, the flywheel may have deep heat cracks. Look for warping. Inspect the threads in the holes for the clutch cover attaching bolts. If they are stripped, they can be restored by installing a thread repair insert. Also, check the flywheel ring gear for damage. If even one ring gear tooth is broken, the ring gear must be replaced. Note that if the ring gear teeth are damaged, you should also check the teeth of the starter drive pinion for damage.

If the flywheel is not obviously damaged, use a straightedge and feeler gauge to check for warped contact surfaces. Manufacturers' specifications as to maximum warpage vary. As a general rule, if more than a 0.01" (0.25 mm) feeler gauge fits under the straightedge, the flywheel must be resurfaced.

A dial indicator also can be used to check for a warped flywheel. In addition, it can be used to check the flywheel runout. Push the flywheel toward the engine to remove crankshaft endplay. Then, mount the dial indicator on a stationary part of the engine with the indicator point bearing on a smooth, relatively undamaged part of the machined flywheel surface, as shown in **Figure 7-25.** Rotate the flywheel and watch the dial to determine how much fluctuation in values there seems to be, which would give an indication of warping. If, rather than a series of fluctuations, the dial shows a steady increase for half a turn and then a steady decrease, flywheel runout may be excessive. In either case, the flywheel must be removed and resurfaced or repositioned.

To check warpage, zero the dial indicator; then, slowly turn the flywheel through about a quarter of a revolution. Watch the indicator face and note if displacement ever exceeds 0.01" (0.25 mm). Without moving the indicator,

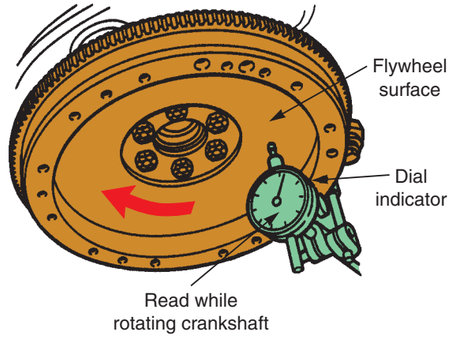


Figure 7-25. *Proper mounting of the dial indicator is important. The base must be solidly attached to the rear of the engine. Push on the flywheel to remove crankshaft endplay. Position indicator so that plunger just touches the flywheel. The dial is then zeroed. (Ford)*

repeat this procedure at least three more times at different positions on the flywheel. If any of the samples produce fluctuations exceeding 0.01" (0.25 mm), the flywheel must be resurfaced.

As mentioned, the surface of the flywheel should also be checked for ***runout.*** This is a condition of a rotating object, such as a shaft or flywheel, in which the surface is not rotating in a true circle or plane. ***Radial runout*** is a measure of out-of-roundness. It is measured at right angles to the centerline of an object. Excessive radial runout may be caused, for example, by a bent shaft. ***Lateral runout*** is a measure of in-and-out movement, or wobble. It is measured in the direction that is lengthwise to the centerline of the rotating object. In other words, it is measured on the plane surface of the rotating object. Excessive lateral runout can result, for example, if a flywheel is not mounted properly.

To check for lateral runout, slowly rotate the flywheel while watching the dial indicator. Determine the lowest point on the flywheel, which corresponds to the lowest reading on the dial. Zero the indicator at this point. Move the flywheel until the highest reading is recorded. This measurement is the lateral runout.

Lateral runout should not exceed the manufacturer's specifications. If it does, the flywheel may not be mounted properly. Remove it and check for burrs between the flywheel and the face of the crankshaft flange. If no burrs exist, check the runout of the crankshaft flange.

Note that while the dial indicator is mounted, you can also measure crankshaft endplay. Push the flywheel forward and rearward and note the displacement on the dial.

Flywheel removal

The easiest way to remove the flywheel attaching bolts is with an impact wrench. If you do not have an impact wrench to remove the flywheel, it must be kept from rotating so the attaching bolts can be loosened. While the bolts are being removed, the flywheel can be held in place using a flywheel turner or locked in place with a flywheel holder; alternatively, a block of wood can be placed between the flywheel and a stationary part of the engine.

Warning: *Always* wear eye protection when using an impact wrench.

A flywheel is very heavy. It can cause injury or severe damage if dropped. Do *not* remove the bolts completely until you have the flywheel secured so that it cannot fall.

Once the flywheel is securely held, the bolts can be loosened and the flywheel can be removed. Sometimes there is a flat metal spacer between the flywheel and the crankshaft flange. The spacer should be saved for reassembly.

After removing the flywheel, check the rear main bearing seal for leaks. If the seal is leaking, oil could reach the new clutch disc and ruin it, just as it may have ruined the old disc. A leaking seal must be replaced.

Flywheel repair

Some flywheels may be damaged beyond repair. Others may be repaired and then reinstalled. Some of these may be fixed by replacing the ring gear or by resurfacing.

Flywheels with damaged ring gears are usually replaced. Some ring gears can be removed from the flywheel and replaced, **Figure 7-26.**

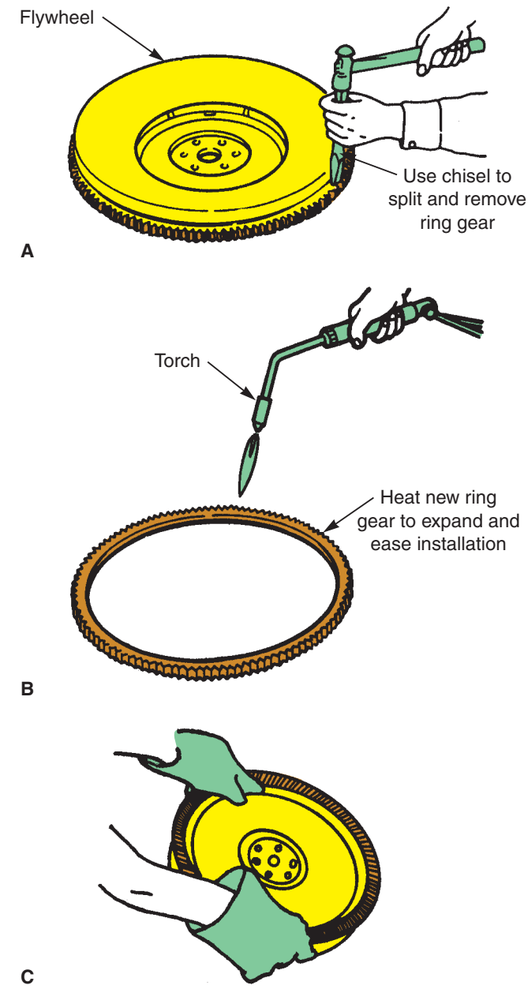


Figure 7-26. *Most manual transmission flywheels have a removable ring gear. A—A chisel is being used to remove the ring gear from a flywheel. Be careful not to damage the flywheel. B—You should heat the replacement ring gear with a torch or in an oven. Be careful not to overheat the ring gear, or the metal will lose its strength. C—Place the new ring gear over the flywheel and ensure that it is properly seated. Always wear gloves or use tongs to prevent burning your hands when handling the hot ring gear. (General Motors)*

Some flywheel ring gears are welded into position; others are a shrink fit. If it is determined that the ring gear is to be replaced, it can be cut from the flywheel with a cutting torch or a metal saw. Ring gears that are welded are commonly removed by breaking the welds with a chisel. Those that are a shrink fit can be heated and then removed with a chisel. See **Figure 7-26A.**

Warning: Wear eye protection during ring gear removal.

If the new ring gear is to be installed by a shrink fit, you can expand the gear by heating, **Figure 7-26B,** or shrink the flywheel by cooling. Usually, the easiest method is to heat the ring gear with a torch. Try to heat the part evenly. Once the ring gear is hot enough (close to but *not* exceeding 450°F [232°C]), it can be placed over the flywheel, **Figure 7-26C.**

Caution: Wear welding gloves when handling the hot ring gear or handle it with tongs.

After the ring gear is placed on the flywheel, it should be checked for proper seating. Make sure the gear is not warped; warpage will cause the starter to jam. Once you have determined that the ring gear is properly installed, stake it or weld it in place, as necessary.

A cracked, scored, or severely overheated flywheel must be resurfaced. A severely cracked flywheel must be replaced. Be sure the replacement flywheel has its balance weights (thickened areas on flywheel) in the proper position. The easiest way to do this is to compare the old and new flywheels. Therefore, never dispose of the old flywheel until reassembly is complete.

Resurfacing a flywheel is a job for a machine shop. Generally speaking, any machine shop that can resurface cylinder heads can resurface a flywheel. The machining process for flywheels is similar to that for cylinder heads.

Flywheels can be resurfaced by turning on a lathe (including a brake lathe), cutting on a milling machine, or grinding on a table with a special grinding wheel. No matter what method is used, the basic process is the same: material is removed until the surface is totally clean and damage-free.

Only a certain amount of metal can be removed, however. If too much is removed, the flywheel will not have sufficient metal to absorb heat. Some flywheels are marked to indicate the maximum amount of metal that can be removed. If the flywheel is not marked, the machine shop will usually be able to tell you if there is enough good metal left in the flywheel. As a general rule, about 0.2″ (5 mm) can be removed from a flywheel that has not been machined before.

Note: If you placed alignment marks on the flywheel face, they will be removed during the machining process. Make a duplicate mark at the exact spot on the back of the flywheel. Some flywheels have alignment dowels. These dowels should be removed before the flywheel is sent to the machine shop for resurfacing.

Flywheel installation

Once the flywheel is resurfaced, it should be reinstalled in its original position. First, reinstall any alignment dowels. Solid dowels are installed by driving them in squarely with a soft-faced mallet. A special tool with a shoulder is needed to drive hollow dowels. Drive the dowels in carefully until they are fully seated. If there was a spacer plate between the flywheel and the crankshaft flange, reinstall it before replacing the flywheel.

Align the crankshaft flange and flywheel bolt holes. They are usually spaced so they will line up at only one location. After the bolt holes are aligned, start the flywheel attaching bolts. Torque the bolts to the proper tension in a crisscross pattern, **Figure 7-27.** Use a flywheel holder or a wood block to hold the flywheel during the tightening operation.

Caution: Do *not* tighten the bolts with an impact wrench. The bolts must be torqued properly.

Flywheel resurfacing

The flywheel is held to the crankshaft flange with special hardened bolts. Do *not* use any other kind of bolt. Be careful not to accidentally swap the flywheel attaching bolts with any others.

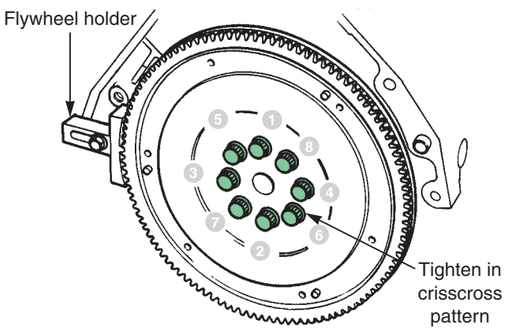


Figure 7-27. *Torque the flywheel attaching bolts in a crisscross pattern. Be sure to use the proper bolts and torque them to specification. Do not use an impact wrench to tighten the bolts. (Honda)*

Clutch Disc Service

In most cases, the clutch disc is replaced when any kind of clutch teardown is done, since it is relatively inexpensive. If the disc was recently replaced or appears to be in excellent condition, it can be reused. Before deciding to reuse the disc, it should be carefully checked.

Warning: Asbestos dust is harmful. Avoid breathing any dust from the clutch disc, as it can contain large amounts of cancer-causing asbestos. Even new clutch discs often contain some asbestos.

If you intend to reuse the clutch disc, do not wash it in any kind of cleaning solvent. Solvent will ruin the clutch disc friction facings.

Inspect the clutch disc for thin or cracked friction material. The disc thickness can be checked with a sliding caliper, as shown in **Figure 7-28.** Usually, however, other indications will be obvious and this step will be unnecessary. Check the disc for loose rivets, oil-soaked friction facings, or broken cushion springs. Make sure the hub flange splines are not worn and they slide freely on the splines of the transmission input shaft. If the clutch disc shows any wear or damage, it should be replaced. **Figure 7-29** shows various types of clutch disc damage you might find during inspection, along with possible reasons damage occurred.

If a replacement disc is to be used, it must be carefully compared to the old one before it is installed. Many clutch problems are caused by installing the wrong replacement disc. It is especially important to check the hub flange size against the old disc. A hub flange that is too large will contact the flywheel and pressure plate, causing clutch disc damage and gear clash. As a final check, slip the replacement disc over the transmission input shaft to make sure it has the correct splines.

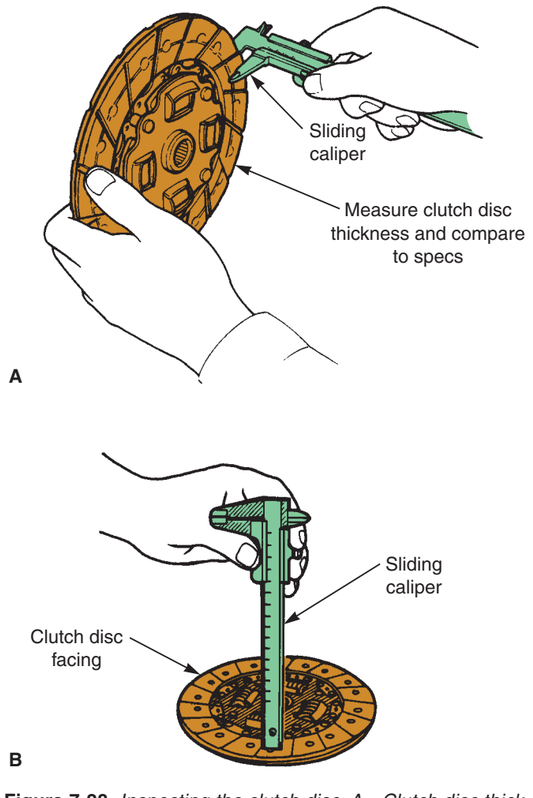


Figure 7-28. *Inspecting the clutch disc. A—Clutch disc thickness can be measured with a sliding caliper. If thickness specifications are available, the thickness can be compared to determine whether the disc can be reused. B—Depth gauge on sliding caliper or depth micrometer can be used to determine the distance from the top of the clutch disc rivets to the surface of the friction facing. If the rivets are too near the surface, the disc is worn out and should be replaced. (Honda, DaimlerChrysler)*

Pressure Plate Assembly Service

The pressure plate assembly is another clutch component that is almost always replaced when the clutch is repaired. You should spend a few moments checking the pressure plate assembly. This will help you determine the cause of the clutch problem and learn how it can be prevented in the future.

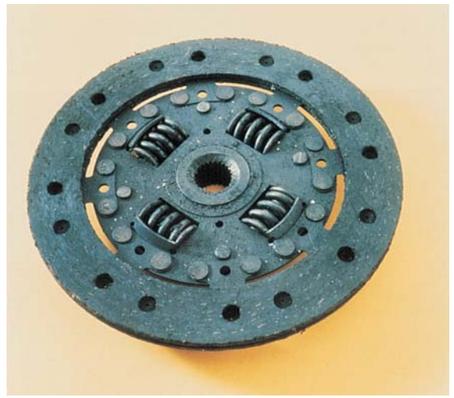
Pressure plate assembly inspection

The pressure plate machined surface develops the same problems as the flywheel surface. Check for wear, scoring, signs of overheating, cracks, and warpage. The pressure plate will usually show more heat damage than the flywheel.

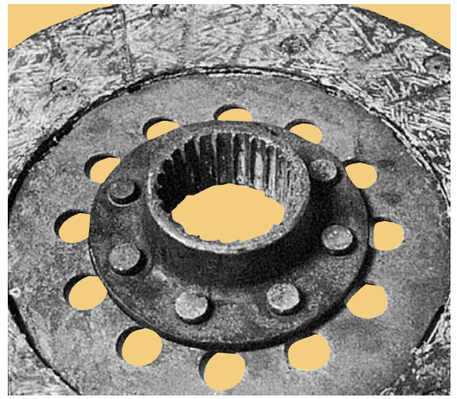
Retaining rivets for diaphragm-spring pivot rings should be checked for looseness. Loose rivets indicate long usage or rough clutch treatment.

Elongation of the bolt holes in the clutch cover is an indication the clutch cover attaching bolts were loose. The pressure plate assembly may bounce against the flywheel if these bolts are loose, which would cause the holes to elongate.

Check for weak pressure plate springs and for signs of overheated springs. The release fingers or levers should be checked for wear and misadjustment. If any fingers or levers are lower than the others, the pressure plate application will be uneven. The clutch may grab or chatter. Severe wear at the contact point with the throwout bearing indicates the clutch has seen much use or there was no free play. **Figure 7-30** shows various types of pressure plate assembly damage you might find during inspection, along with possible reasons the damage occurred. This damage may range from chatter marks on the pressure plate to a scored pressure plate or broken release levers. Being able to readily identify the damage will result in better service times.

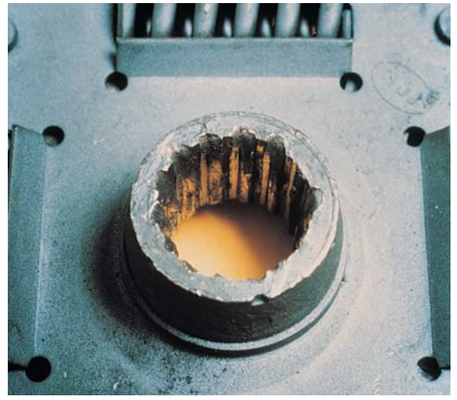


A—Burned disc facing—Oil contamination, slipping clutch, insufficient clearance adjustment.



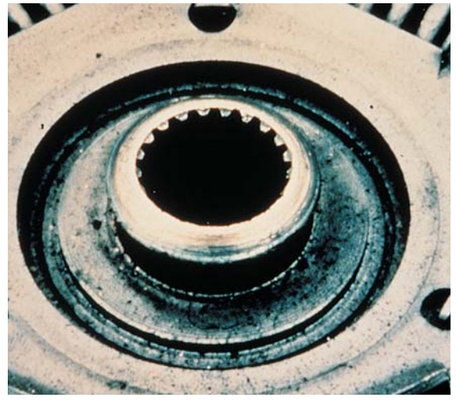
B—Hub splines worn—Improper engine-to-transmission alignment, damaged input shaft, bad pilot bearing.

C—Worn disc facing—Weak pressure plate springs, normal wear, scored or cracked flywheel.



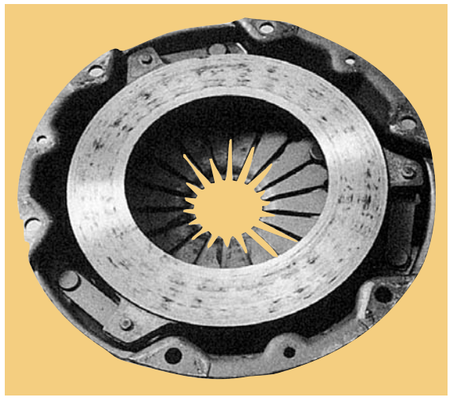
D—Damaged hub splines—Transmission drawn into place with bellhousing bolts.

E—Scored disc facing—Flywheel not machined when needed, bad pressure plate reused.

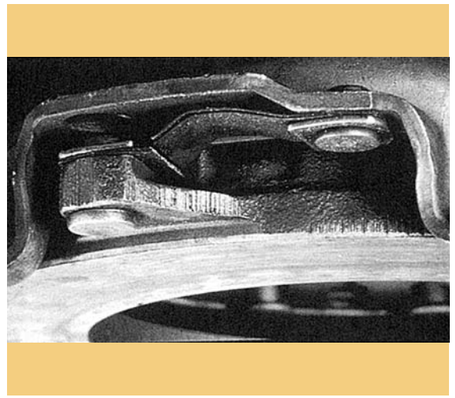


F—Wear on hub—Installed backwards, wrong parts.

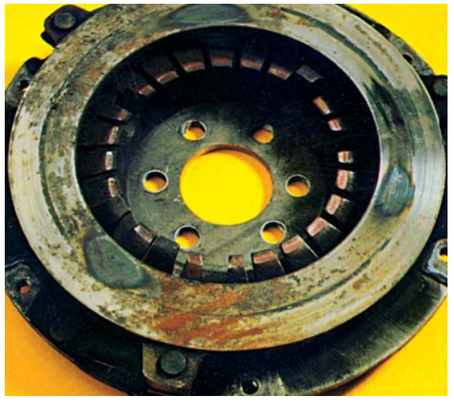
Figure 7-29. *Study the types of clutch disc damage. (Luk)*



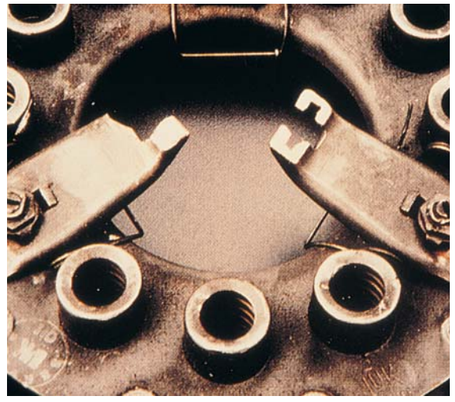
A—Chatter marks on pressure plate—Oil or grease contamination, binding linkage, loose or soft motor mounts, worn driveline parts.



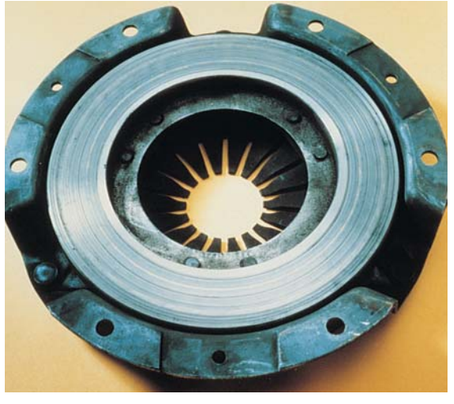
B—Broken pressure plate retracting spring—Normal fatigue, wrong clutch for vehicle, low-quality pressure plate.



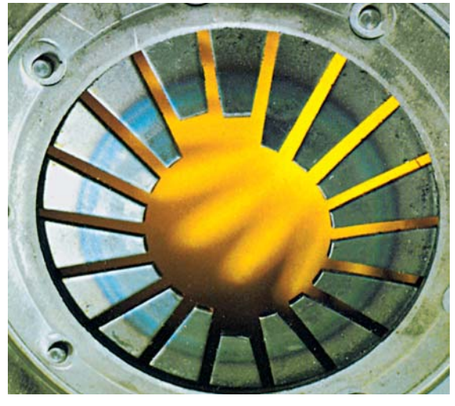
C—Pressure plate hot spots or heat checks—Clutch slippage, oil or grease contamination, clutch adjustment too tight, binding linkage, driving habits.



D—Broken release levers—No free play in clutch adjustment, bad release bearing, improper part alignment.



E—Scored pressure plate—Clutch disc worn to rivets, adjustment too tight, clutch slippage, binding linkage.



F—Broken diaphragm spring—Installation error, excessive pedal reserve causing throwout bearing to travel too far during disengagement.

Figure 7-30. *Study the types of pressure plate assembly damage. (Luk)*

Pressure plate assembly repair

Most repair shops choose to completely replace pressure plate assemblies, rather than rebuild them. It is possible, however, with the proper equipment, to take apart a pressure plate assembly and replace just the parts that are worn. This is typically done on an assembly line by large automotive rebuilders. As a general rule, pressure plate assemblies that are put together with nuts and bolts can be rebuilt, while pressure plates held by rivets cannot be rebuilt. If a shop decides to rebuild a pressure plate assembly, it must closely follow the manufacturer's directions. A general procedure for rebuilding a pressure plate assembly is shown in **Figure 7-31.** Remember to wear eye protection!

Throwout Bearing Assembly Service

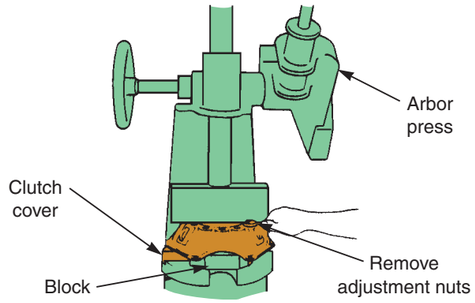
The throwout bearing is almost always replaced when the clutch is serviced. It is often a source of problems. If the bearing must be reused, it should be carefully checked for defects.

Caution: If you intend to reuse a throwout bearing, do not wash it in any kind of cleaning solvent. Solvent will dissolve the throwout bearing lubricant, which cannot be replaced.

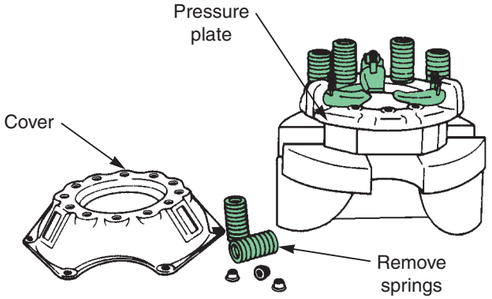
Throwout bearing assembly inspection

Check the throwout bearing for roughness by attempting to rotate it by hand. If rotation is rough, or if it appears to have lost its grease, it should be replaced.

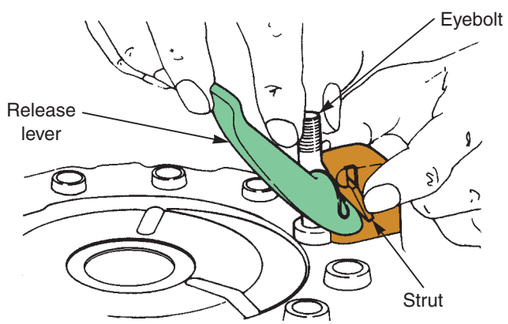
Check the bearing collar for a free (but not loose) fit on the hub of the transmission's front bearing retainer. A loose fit indicates that the collar or hub, or both, is worn. Check the collar where it contacts the clutch fork. If the collar is worn, the fork usually is worn also. Any worn parts should be replaced. **Figure 7-32** shows damage related to the throwout bearing, which you might find during inspection, along with possible reasons the damage occurred.



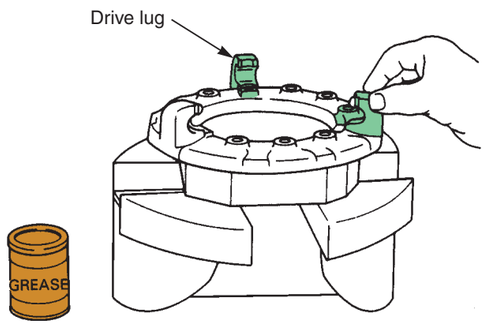
A—Use an arbor press to compress pressure plate apply springs so that the assembly can be taken apart. Place and arrange the block under the pressure plate so that the cover is free to move down. Remove the eyebolt adjustment nuts, which are used to adjust the release lever height, from clutch cover. Slowly *release the arbor press so the cover can be removed without the apply springs flying out.*



B—Carefully mark positions of all springs and release levers. This will ensure parts are reinstalled in their original positions. Organize the disassembled parts of the pressure plate assembly on the workbench. Replace all parts that show wear.

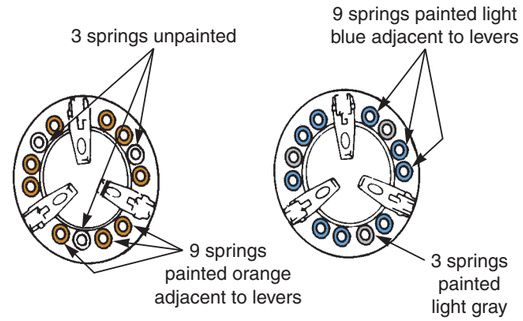


C—Remove release levers. To do this, lift up on the lever and remove the strut. Keep all parts of each particular lever together.

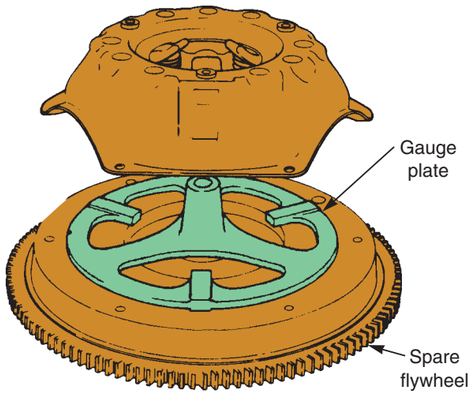


D—Grease the pressure plate drive lugs with high temperature grease, after inspecting assembly for cracking, wear, and other damage.

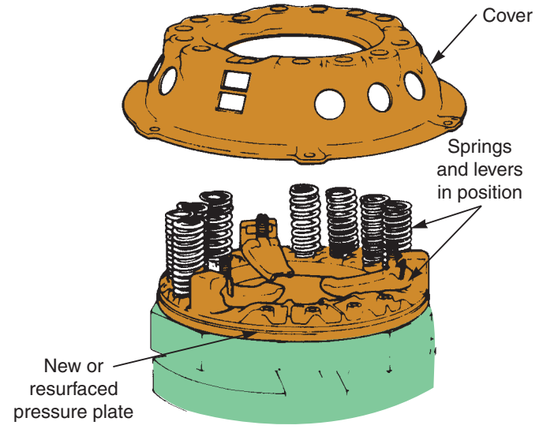
Figure 7-31. *Procedures A through H illustrate the steps in a coil-spring pressure plate assembly overhaul. This procedure is general, and the manufacturer's service manual should always be consulted. (General Motors)* *(continued)*


3 springs unpainted
9 springs painted light blue adjacent to levers
9 springs painted orange adjacent to levers
3 springs painted light gray

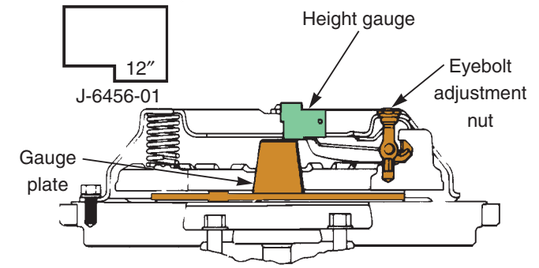
E—To reassemble, install the release levers and apply springs. Basically, install the release levers by reversing the procedure for removal. If new springs are used, install them using the sequence shown; otherwise, return the springs to their original positions.



G—To ensure uniform clutch application, the release levers must be set to equal heights. Place the gauge plate on the spare flywheel, and place the pressure plate assembly over it. The gauge plate occupies the position normally occupied by the clutch disc and simulates installed component positions. Bolt the clutch cover to the flywheel. Note that spacers or shims may be used instead of gauge plate.



F—With the pressure plate assembly positioned on the arbor press as per original setup, slowly apply pressure to the clutch cover. The drive-lug openings in the clutch cover should fit over the drive lugs; apply springs should fit into their seats, as shown. Screw the eyebolt adjustment nuts onto the eyebolts until their tops are flush. Slowly release the arbor press and remove the assembly.



H—Position the height gauge on the hub of gauge plate. Turn the eyebolt adjustment nut until the lever is flush with the height gauge. Adjust all levers in this manner. Stake all adjustment nuts when finished so they will not loosen in service. A straightedge can also be used and placed across the cover. Levers can then be set to a height at some specified distance down from the straightedge. Remove the clutch cover from the flywheel, loosening the bolts gradually until spring pressure is relieved.

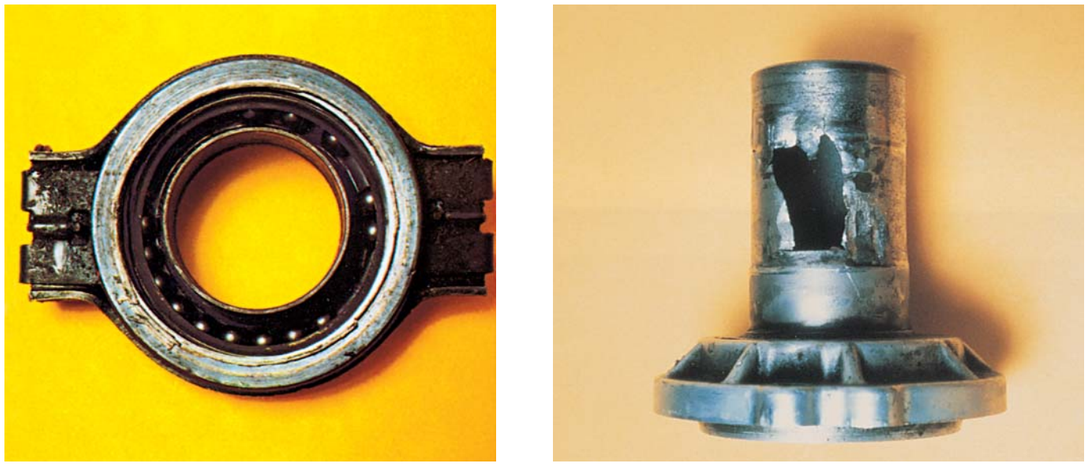
Figure 7-31. *Continued*

Throwout bearing assembly repair

Some throwout bearings are an integral part of the bearing collar. These are replaced as a unit. Many throwout bearings, however, are a press fit onto the bearing collar. The assembly can be repaired by replacing the bearing or collar—whichever is in need of repair.

Replacement bearings must be pressed onto the collar after the old bearing is removed. To remove the throwout bearing, press it from the collar using a bench vise or press. Adapters may be necessary to properly perform the pressing operation. Press on the new throwout bearing. It should be fully seated on the shoulder of the bearing collar when complete. Refer to **Figure 7-33.**

Caution: Do not apply driving force through the bearing elements when installing the throwout bearing.



A B

Figure 7-32. *A—Dry, worn throwout bearing—Riding clutch, improper clutch adjustment. B—Worn front bearing retainer hub—Bent fork or fork mount.*

After the bearing is in place, rotate it by hand and make sure it rotates smoothly. It should turn without binding or roughness.

Clutch Fork Service

A bent or worn clutch fork can prevent the clutch from releasing properly. Inspect the clutch fork for such signs of damage. Look for wear at the throwout bearing mount. On lever-type clutch forks, check the pivot-point contact area. Inspect the spring clip that holds the clutch fork to the pivot point. On shaft-type clutch forks, check the pivot shaft for wear.

If inspection reveals a damaged clutch fork, the fork must be removed (if it is not already) and replaced. The lever-type clutch fork is removed when the clutch is disassembled. The shaft-type clutch fork can be removed by first removing the pivot, or clutch release, shaft. The shaft is usually held by a clip, **Figure 7-34A.** Once the clip is removed, the shaft will slide out of the housing and the fork can be removed from the shaft, **Figure 7-34B.** With the fork assembly apart, you can also check the pivot shaft for wear.

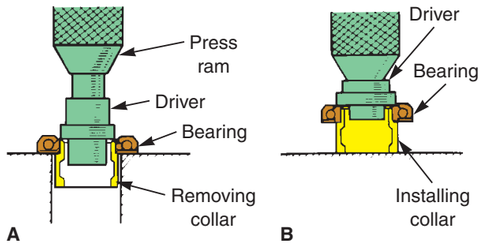


Figure 7-33. *Replacing a throwout bearing. A—The throwout bearing can be removed from its collar by using a press. The proper adapter must be used. In many cases, the bearing can be removed and replaced by using a bench vise. B—This illustrates the bearing installation procedure. Be careful not to exert any pressure on the rolling elements or outer race. (Toyota)*

Clutch Housing Service

Clutch housings usually are not a source of problems. It is important, however, that they be inspected for damage. Clean the clutch housing interior and exterior. Then check the housing for cracks and damage to mounting surfaces. Any damage is grounds for replacement.

Also, check the clutch fork ball stud for wear. It should be undamaged and tight. If the stud must be replaced, it can usually be removed from the clutch housing with a large Allen wrench or a differential-plug removal tool.

Clutch Installation

The following section presents the general procedures for installing a clutch safely and properly. The exact procedure for clutch installation varies according to the engine and drive train layout. You should always refer to the manufacturer's service manual for specific procedures and techniques to install a clutch safely and properly.

Front-Engine, Rear-Wheel Drive

The following procedure details the proper way to install a clutch in a front-engine, rear-wheel drive vehicle:

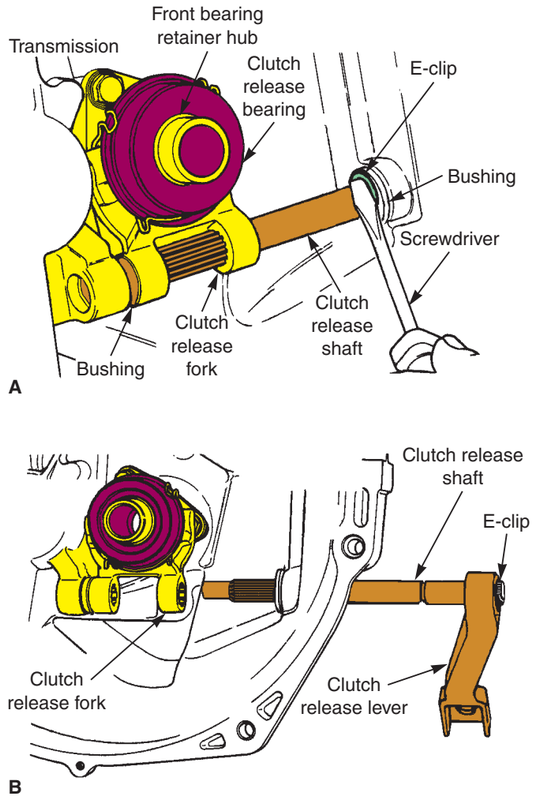


Figure 7-34. *This type of clutch fork uses a shaft mounting. It must be disassembled to remove the fork. When the shaft is out of the housing, it should be checked for wear. A—Remove the retaining E-clip. B—Remove the clutch release shaft. (DaimlerChrysler)*

1. Pilot bearing and flywheel installations were detailed previously in respective service sections. As a preliminary step, recheck the pilot bearing and flywheel to make sure they are installed properly.
2. Install the clutch disc and pressure plate assembly onto the flywheel. If one side of the disc is marked flywheel, place that side against the flywheel. If not marked, study the disc, flywheel, and assembly to determine which way the long side of the hub should fit into the assembled clutch. It should be fairly obvious. Use your alignment tool, **Figure 7-35.** It will hold the disc in place and keep the disc hub aligned with the pilot bearing. This way, the input shaft will go in smoothly when you attempt to reinstall it.

Caution: When handling clutch parts, make sure your hands are clean. It is important that no oil or grease contact the clutch disc.

Match holes in the assembly to flywheel dowels, where applicable. Otherwise, align punch marks that you made during removal. Some pressure plate assemblies will be aligned through offset bolt holes. If none of these reference marks are available, turn the pressure plate assembly on the alignment tool and align bolt holes with the nearest threaded holes in the flywheel.

3. Begin threading in the clutch cover attaching bolts. Install two directly opposite each other, finger-tightening them. The clutch will now support itself. Thread in and finger-tighten the remaining bolts, making sure all bolts are started properly.

Caution: The bolts used to hold the pressure plate assembly to the flywheel are high-strength bolts. Do not use low-tension "hardware-store" replacements, as they will probably break and cause a clutch explosion.

Finish tightening the clutch cover attaching bolts by torquing them down gradually in a crisscross pattern. Make sure the pilot shaft does not sag as you tighten the bolts. Putting a slight upward force on the pilot shaft will help to retain the alignment of the clutch disc. Finish tightening the bolts to the proper torque given by the manufacturer. Once the bolts are tightened, make sure the clutch pilot shaft slides in and out freely. See **Figure 7-36.**

4. If so equipped, lubricate the seat of the clutch fork ball stud in the clutch housing. Use high-temperature grease. Install the spring clip in the fork. Force the ball stud into the fork recess so that it is engaged by the clip.

If the clutch fork is the shaft type, assemble by passing the release shaft through the clutch housing and clutch fork. Lubricate the parts as necessary and lock them in place with the retaining E-clip. If lock bolts are used, be sure to torque them properly.

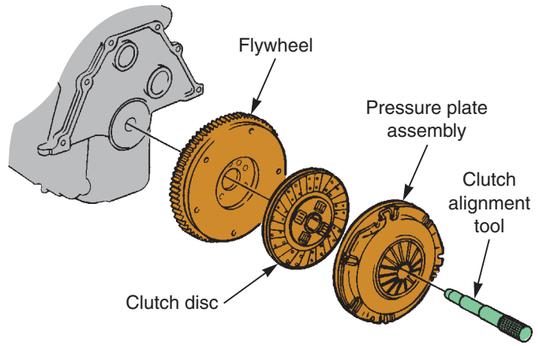


Figure 7-35. *Study the relative position of the clutch parts and the clutch pilot shaft. Use of a clutch pilot shaft will make transmission reinstallation much easier. (General Motors)*

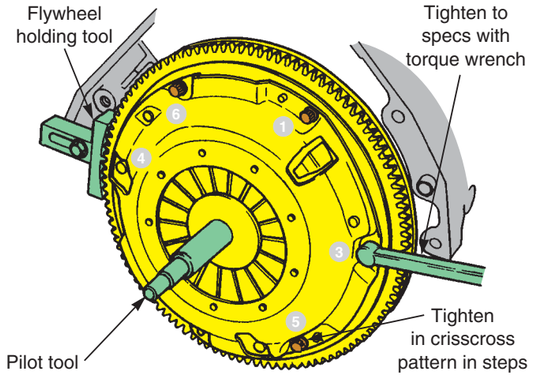


Figure 7-36. *The clutch cover attaching bolts should be turned down gradually in a crisscross pattern. Push up lightly on the pilot shaft during tightening. This will ensure the disc holds its alignment. Bolts should be torqued to specifications. Once the bolts are tight, remove the alignment tool. Try sliding it in and out a few times to see that it does not bind. If it does, the transmission will be difficult to install. (Toyota)*

5. Pack the inside of the throwout bearing collar with high-temperature grease. Typically, collars have an outer groove for the clutch fork. The groove should be lightly coated with grease. Refer to **Figure 7-37.**

   Install the throwout bearing assembly on the fork. Use clips or retaining springs to secure the bearing to the fork. In cases where the clutch and transmission housings are one, it will be necessary to slide the bearing assembly onto the hub of the front bearing retainer first. See **Figure 7-38.**
6. If the clutch housing was removed, install it now. (A clutch housing that is integral with the transmission case is installed with the transmission.) Before installation, check for dirt or paint that could throw the housing out of alignment. As you tighten the clutch

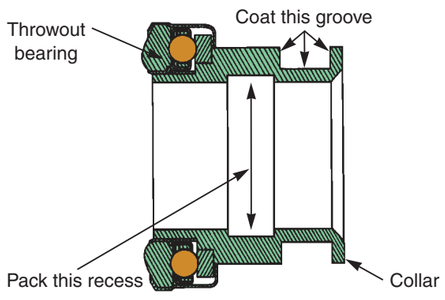


Figure 7-37. *If the throwout bearing is not lubricated properly, it will bind on the hub of the transmission's front bearing retainer, or it will wear rapidly. Apply the proper type of grease to the places shown. (DaimlerChrysler)*

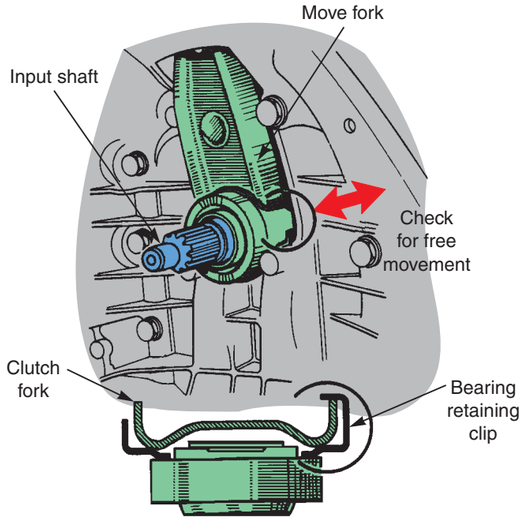


Figure 7-38. *In this design, the bellhousing is an integral part of the transmission housing. The throwout bearing is placed on the front bearing retainer hub. The clutch fork is installed, and then, the bearing is secured to the clutch fork. Once assembled, the clutch fork and bearing are checked for smooth operation. Note how the bearing attaches to the clutch fork in this design variation. (DaimlerChrysler)*

housing attaching bolts, make sure wires or other vehicle components do not get pinched between the housing and the engine block. Tighten the bolts in a crisscross pattern and torque them to the manufacturer's specifications.

7. Using a transmission jack, install the transmission as outlined in Chapter 9, sliding the input shaft into engagement with the throwout bearing (where clutch housing is separate), clutch disc splines, and pilot bearing. To align the input shaft and clutch disc splines, use the transmission output shaft to turn the input shaft. It may be necessary to slightly shift or wiggle the transmission to get the input shaft through the clutch disc and into the pilot bearing. If the pilot shaft was used properly, the input shaft should enter the clutch assembly without too much difficulty.

Caution: If the transmission shows any sign of oil leakage through the front bearing retainer, correct the leak before installing the transmission.

If the clutch housing is part of the transmission, bolt the unit to the back of the engine. If the clutch housing is separate, bolt the transmission case to the housing. Start the attaching bolts as soon as the input shaft is slid into place and the mating housing

surfaces are flush. This will keep the transmission from hanging and damaging the clutch hub splines or the input shaft.

Caution: Do *not* use the bellhousing or transmission case attaching bolts to try to draw in a binding transmission. This could bend the clutch disc hub or break the bellhousing or transmission case ears. Also, the transmission input shaft could damage the pilot bearing. If the clutch and pilot bearing are installed correctly, the transmission should slide fully into place by hand.

8. Reconnect the pushrod or cable and return spring connected to the clutch fork. Then, adjust, repair, or replace the linkage as outlined earlier in this chapter. Install any other parts, such as the speedometer cable, shift linkage, or connector wires.
9. Reinstall the rear drive shaft assembly as detailed in Chapter 13. If the vehicle has a front drive shaft, install it now. After the drive shaft or shafts are installed, ensure all other drive train connections are made.
10. Check the transmission lubricant and add fluid, if necessary. Reconnect the battery negative cable. Lower the vehicle and perform a road test. During the road test, make sure there is no slippage, the clutch engages and disengages smoothly, and the free play is correct. Operate the clutch at least 25 times to properly seat the clutch mating surfaces. Do not overheat the clutch during this time.

Front-Engine, Front-Wheel Drive

With a few exceptions, the general clutch installation procedure for front-engine, front-wheel drive vehicles duplicates clutch installation for front-engine, rear-wheel drive vehicles. Drive axles are replaced instead of the drive shaft assembly. Reinstalling the several variations of front drive axles is covered in detail in Chapter 15. Also, in the previous section, substitute references to the transmission with transaxle. Installing the transaxle is covered in detail in Chapter 11. On vehicles requiring that the engine also be removed for clutch replacement, refer to the manufacturer's service manual.

Summary

Clutches can develop problems for many reasons. It is normal for a clutch to wear out after 50,000 miles (80,000 km). If a clutch wears out sooner, there may be another problem that caused premature clutch failure. The most common cause of early clutch failure is driver abuse.

Clutch problems can be divided into different groups. The most common clutch problem is slippage. Slippage occurs when the clutch is engaged but does not transmit all of the engine power. Slippage can be caused by a worn-out clutch, improper linkage adjustments, or oil on the clutch facings. Less common causes are a warped flywheel, clutch disc, or pressure plate, or worn pressure plate apply springs. A slipping clutch should be fixed before excess heat ruins other clutch parts.

Clutch vibration can be caused by loose or unbalanced clutch parts. Loose parts usually also cause noise. Sometimes, what appears to be a clutch vibration is caused by loose engine mounts, loose clutch mounting bolts, or excessive crankshaft endplay.

Clutch noises are often caused by defective bearings. The defective bearing can be isolated by operating the clutch pedal. Depending on clutch pedal position, the pilot bearing, throwout bearing, or transmission front bearing can be at fault. Rattles and knocking noises are almost always caused by loose parts.

Clutch grabbing is usually caused by oil on the clutch facings. Other possible causes are glazed clutch facings or wear and misalignment of the throwout bearing assembly or clutch fork.

Clutch chatter is similar to grabbing, but it is heard more than felt. It can be caused by some of the same defects that cause grabbing. Sometimes chatter is caused by a buildup of clutch dust on the friction facings.

A pedal that is hard to push may be caused by a binding condition in the linkage or a throwout bearing that is sticking on the front bearing retainer hub. A new pressure plate assembly with excessively stiff springs may have been installed.

A clutch that does not release may have a defect in the linkage. Rod-and-lever linkages or cable linkages may be broken or disconnected. A hydraulic linkage may be out of fluid. If the linkage checks out, the problem is inside the clutch assembly. In some cases, the clutch disc may have welded itself to the flywheel or pressure plate.

All types of clutch linkage have some provision for adjusting the free play. Free play is measured at the clutch pedal. The usual free play measurement is between 1″ and 1.5″ (25 mm and 38 mm).

The clutch linkage may need lubrication or repair. Rod-and-lever linkages may require new bushings or realignment of linkage parts. Cable linkages may have problems due to a corroded or kinked cable. The cable must usually be replaced.

Hydraulic linkages can leak, or the hydraulic lines can be kinked or swelled shut. Leaks can be spotted by a visual examination.

Master and slave cylinders can be rebuilt if necessary. After rebuilding, or whenever the hydraulic system has been opened, air must be removed from the system. The process of removing air is called bleeding.

To remove the clutch from a vehicle, other components must be removed. In most cases, the drive shaft assembly or drive axles must be disconnected from the vehicle. The transmission and clutch housing are then removed to reach the clutch assembly.

To remove the clutch assembly, the clutch cover attaching bolts are removed from the flywheel. Then, the pressure plate assembly and clutch disc are removed from the flywheel.

The flywheel and pilot bearing should be checked for defects. A worn or damaged pilot bearing should be replaced. An overheated or warped flywheel can be resurfaced by a machine shop. The flywheel ring gear teeth should be checked for damage. A damaged ring gear can be removed. The replacement ring gear is installed by heating it and placing it over the flywheel.

The clutch disc is almost always replaced during a clutch teardown. The disc can be checked to determine the cause of failure. This may help avoid a similar clutch failure in the future.

Always check the new disc to make sure it is the proper replacement. Many clutch problems after overhaul are caused by using the improper clutch disc.

The pressure plate assembly is usually replaced as part of a clutch overhaul. Some assemblies can be rebuilt. The rebuilding process requires the use of a press.

The throwout bearing should be checked for roughness and lack of grease. Always replace a throwout bearing that shows any sign of defects. The throwout bearing can be pressed from its collar, and a new bearing can be installed. The clutch fork should be checked for wear. Worn forks should be replaced.

Clutch housings do not wear out, but they should be checked for cracks and warping. The housing may contain a ball stud for the clutch fork. The stud should be checked for wear and replaced if necessary.

When reassembling the clutch, always make sure your hands are free from oil. Oil or grease on the clutch disc will cause grabbing or slippage. A pilot shaft should be used to ensure the disc hub splines and pilot hole line up closely. If proper alignment is not obtained, the transmission will be difficult to install. The clutch cover attaching bolts should always be tightened with the pilot shaft in place.

After the clutch and other drive train parts are reinstalled, the clutch pedal free play should be adjusted to specifications. Road test the vehicle as the final step.

Review Questions—Chapter 7

Please do not write in this text. Place your answers on a separate sheet of paper.

1. Explain what the phrase *riding the clutch* means. What effect can it have on the clutch over time?
2. Which of the following items concerning the phrase *dumping the clutch* is *not* true?
   (A) Pressure plate apply springs engage gradually.
   (B) Means increasing engine speed and then suddenly releasing the clutch pedal.
   (C) Causes instant heat buildup on clutch disc facings and places tremendous stress on the drive train.
   (D) Is a form of clutch abuse.
3. Vibration that occurs when the clutch is being engaged or disengaged is called _____.
4. A deep knocking noise that is similar to an engine main or rod bearing knock is an indication of _____.
   (A) defective bearings
   (B) a loose clutch fork
   (C) weak retracting or cushion springs
   (D) loose flywheel attaching bolts
5. Clutch adjustment involves _____.
   (A) resurfacing the flywheel
   (B) rebuilding the pressure plate assembly
   (C) setting clutch free play
   (D) All of the above.
6. Why should you not let a transmission hang after removing its mounts?
7. Briefly cite two methods that may be used to remove a pilot bearing from the crankshaft bore.
8. The flywheel face and pressure plate should be cleaned with a(n) _____ cleaner.
9. When inspecting a flywheel, what trouble signs should you look for?
10. Briefly summarize typical steps involved in the clutch reassembly process for a front-engine, rear-wheel drive vehicle.

ASE-Type Questions—Chapter 7

1. Each of the following operator actions can cause early clutch failure *except:*
   (A) riding the clutch pedal.
   (B) disengaging the clutch when decelerating.
   (C) dumping the clutch.
   (D) overloading the vehicle.
2. Technician A says that light clutch drag can cause gear clashing. Technician B says that clutch disc spindown can be mistaken for clutch drag. Who is right?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
3. Technician A says that some clutch slippage is necessary for smooth shifts. Technician B says that an oil-soaked clutch disc will slip, even if it is not worn. Who is right?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.

4. Each of the following can cause clutch slippage *except:*
   (A) excessive pressure plate apply spring pressure.
   (B) warped flywheel or pressure plate surfaces.
   (C) worn clutch disc.
   (D) misadjusted linkage.
5. Technician A says that clutch grabbing and clutch chatter are the same condition. Technician B says that clutch vibration or chatter could be caused by broken engine or transmission mounts. Who is right?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
6. If a noise is heard when the clutch pedal is completely released (up position) with the engine running, which of the following bearings is probably defective?
   (A) Engine rear main bearing.
   (B) Clutch pilot bearing.
   (C) Throwout bearing.
   (D) Transmission front bearing.
7. Technician A says that automatic transmission fluid can be used to refill a hydraulic clutch linkage reservoir. Technician B says that kinked clutch linkage cable can be lubricated to restore normal operation. Who is right?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
8. Each of the following is caused by improper clutch adjustment *except:*
   (A) clutch drag.
   (B) clutch slippage.
   (C) grabbing clutch.
   (D) throwout bearing wear.
9. Technician A says that a badly slipping clutch usually cannot be fixed by adjusting the linkage. Technician B says that free play at the clutch pedal should be measured before attempting to adjust the clutch linkage. Who is right?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
10. Opening the slave cylinder bleeder valve while pressing on the clutch pedal will cause the pedal to _____.
    (A) slowly rise
    (B) become hard to push
    (C) go to the floor
    (D) lock up
11. A pilot shaft is used to align the pilot bearing and the _____.
    (A) pressure plate
    (B) clutch disc
    (C) input shaft
    (D) throwout bearing
12. Technician A says that one should never work under a vehicle that is supported only by a hydraulic jack. Technician B says that jack stands should always be placed under a vehicle that has been raised on a hoist. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.
13. Technician A says that pilot bearings should be carefully checked once the clutch is removed. Technician B says that the flywheel should not be removed unless it is damaged or needs resurfacing. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.
14. A flywheel has deep scoring and cracks. Technician A says that any amount of metal can be cut from the flywheel to fix this condition. Technician B says that the flywheel can be lightly sanded and reused. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.
15. Technician A says that a clutch disc should be reused unless wear or damage is severe. Technician B says that all replacement clutch parts should be carefully compared to the old parts to help ensure they will work properly. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.
16. Technician A says that a pressure plate must apply evenly to prevent clutch grabbing. Technician B says that the throwout bearing should be replaced if it shows any signs of wear or damage. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.

17. A car has a slipping clutch. The car will still move, but the engine races when accelerating. Technician A says to pull the transmission and replace the clutch. Technician B says to adjust the clutch linkage first. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.

18. A car shudders when accelerating from a standstill as the clutch pedal is released. Technician A says to check for loose, softened, or broken motor mounts. Technician B says to check the clutch and flywheel friction surfaces for problems. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.

19. A clutch makes a grinding sound as the clutch pedal is depressed and the engine is running. Each of the following could cause the problem, *except:*
    (A) misadjusted clutch linkage.
    (B) oil or grease on the clutch.
    (C) warped clutch disc.
    (D) warped pressure plate.

20. A driver complains that the clutch is not working properly. The car is equipped with a hydraulic linkage. An inspection shows that the slave cylinder is not responding to pedal action. Fluid level is all right. Technician A says to try bleeding the hydraulic system first. Technician B says to replace the seals in the system first. Who is right?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.